APPENDIX C

WATER RESOURCES

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APPENDIX C
WATER RESOURCES

Appendix C contains technical water resource information (including tables and figures) regarding the description of the affected environment. The more general, non-technical description of the water resources affected environment is provided in Section 3.2 of the Environmental Impact Statement (EIS).

All tables and figures are located at the end of Appendix C.

Hydraulic Properties of the Carrizo-Wilcox

The three principal hydraulic properties of an aquifer that determine the rate of groundwater movement, the amount of water stored in an aquifer, and the amount of water that can be withdrawn from an aquifer are the hydraulic conductivity, transmissivity, and storage coefficient. Horizontal hydraulic conductivities, which quantify the volume of flow per unit area in an aquifer under a unit hydraulic gradient, are highest in sand units, which range from 20 to 60 feet per day, while zones of clay and silt and interchannel areas high in clay have hydraulic conductivities of 3 to 7 feet per day (Thorkildsen and Price 1991). Horizontal hydraulic conductivities of sand units in major sand aquifers such as the Carrizo and the Simsboro often increase with an increase in sand thickness and can reach values as high as 200 feet per day. Transmissivity is the product of the horizontal hydraulic conductivity and the thickness of the unit and is a measure of the amount of water that can be transmitted by an aquifer under unit hydraulic gradient. Transmissivities range from low values of less than a few hundred feet squared per day in the clays of the Calvert Bluff aquifer to high values of 14,000 to 24,000 feet squared (ft^2) per day in the sands of the Carrizo and Simsboro aquifers. Storage coefficients relate to the percentage of an aquifer that is capable of storing groundwater. For artesian sections of the aquifers, storage coefficients are in the range of 1×10^{-4} to 1×10^{-5}. In the water table sections of the aquifers, storage coefficients are approximately the same as the porosity of the aquifers and are in the range of 0.1 to 0.3. The hydraulic properties of the Carrizo-Wilcox aquifer system in east-central Texas are shown in **Table C-1**.

Studies of aquifer properties in the Sandow Mine area have been conducted by R. W. Harden & Associates, Inc. (RWHA) (1999) and Hall Southwest Water Consultants (1985). The studies show that sand channels in the Calvert Bluff have transmissivities in the range of 10 to 1,100 ft^2 per day, with most values falling in the range of 270 to 670 ft^2 per day. Hydraulic conductivities range from less than 1 to 31 feet per day, with most values falling in either the low range of 4 to 10 feet per day or the upper range of 20 to 30 feet per day. The storage coefficient for the Calvert Bluff is in the range of 2×10^{-4} to 5×10^{-4}, with the specific yield of the sandy units being approximately 0.15. Groundwater flow rates are approximately 4 feet per year in clay and 35 feet per year in sand units. Hydraulic properties of the Sandow Mine aquifers are presented in **Table C-4**.

In the Sandow Mine area, the Simsboro aquifer has transmissivities in the range of 2,100 to 7,900 ft^2 per day, with most values falling in the range of 2,600 to 6,700 ft^2 per day. Hydraulic conductivities range from 13 to 40 feet per day. Storage coefficients are usually between 1×10^{-5} and 4×10^{-4}.

Mined areas at Sandow that have been backfilled and reclaimed with spoil have distinctive hydraulic properties that may affect local long-term groundwater recharge through the spoil material. Transmissivities in the replaced spoil material are in the range of 54 to 250 ft^2 per day. Hydraulic conductivities range from less than 1 foot per day to only 2.5 feet per day. The specific yield is from 0.02 to 0.04, suggesting very tight clay-rich material.

Although no detailed studies of aquifer interconnection at the Sandow Mine have been made, Hall Southwest Water Consultants (1985) reported that the ratio of vertical hydraulic conductivity to horizontal hydraulic conductivity in the Calvert Bluff ranged from 1×10^{-3} to 1×10^{-5} in the mine area. This makes the vertical permeability of the Calvert Bluff aquifer at least 1/1000 of the horizontal permeability and suggests very little vertical flow of groundwater in the Sandow Mine area.

Groundwater Quality in the Carrizo-Wilcox Aquifers

Groundwater in the Carrizo-Wilcox aquifer system is mainly fresh to slightly alkaline (pH of 7.0 to 8.0 standard units) and useable for domestic consumption and irrigation. Most wells have total dissolved solids (TDS) of less than 1,000 milligrams per liter (mg/l), and the majority of the wells have TDS levels below 500 mg/l. **Table C-2** gives the mean and range of various constituents in the groundwater of the Carrizo-Wilcox aquifer system of east-central Texas (Thorkildsen and Price 1991). Iron is generally in the range of 2.0 to 4.0 mg/l. The groundwater is generally dominated by calcium and sodium bicarbonate, with sulfate less than bicarbonate and chloride ranging from 50 to 200 mg/l. The sodium adsorption ratio (SAR) is generally below 10; this parameter is important for irrigation use of groundwater, and values below 10 are desired. The iron content of the groundwater indicates that the water may need to be treated prior to domestic use. The chemical quality of groundwater in wells in the outcrop zone of the Carrizo-Wilcox system in east-central Texas as sampled by Thorkildsen and Price (1991) is presented in **Figure C-4**.

As groundwater traverses downdip in the aquifers of the Carrizo-Wilcox aquifer system, it becomes more mineralized due to reaction with the minerals and clays in the sedimentary rocks. As shown in **Figure C-4**, the groundwater becomes highly saline reaching TDS concentrations of 3,000 mg/l or more approximately 35 miles southeast of the belt where the sedimentary units of the Carrizo-Wilcox outcrop and receive recharge from precipitation (see **Figure 3.2-4**). For the Simsboro and Carrizo aquifers, the two main water supply aquifers in the Carrizo-Wilcox system, this downdip limit of fresh to slightly saline groundwater follows a line running approximately through Somerville Lake, College Station, and Madisonville and trending in a northeast-southwest direction (**Figure C-5**). Beyond this limit of fresh to slightly saline groundwater, groundwater in the Carrizo-Wilcox aquifer system is not useable for municipal, domestic, or agricultural purposes without treatment. Between this limit and the outcrop belt of the Carrizo-Wilcox aquifer system (**Figure 3.2-4**), groundwater is generally useable for domestic and agricultural purposes. Groundwater quality in the Sandow Mine area is similar to that found throughout the Carrizo-Wilcox aquifer system. **Table C-5**, taken from RWHA (1999), summarizes groundwater quality at the Sandow Mine.

Reclaimed mine spoils at the Sandow Mine often contain groundwater. The time for groundwater recovery in the reclaimed spoil material varies depending on the permeability of the spoil and the adjacent Calvert Bluff units. Groundwater quality in the reclaimed areas reflects the nature of the spoil that was used for backfill and reclamation. The pH of groundwater in the reclaimed areas ranges from 5.5 to 7.7 standard

units and averages 6.4 standard units. TDS ranges from 1,108 to 6,570 mg/l and averages 3,925 mg/l. Sulfate ranges from 240 to 2,400 mg/l and averages 1,176 mg/l. Iron ranges up to 22.6 mg/l and averages 11.76 mg/l. Manganese averages 4.15 mg/l. Thus, groundwater in the reclaimed spoil is considerably higher in sulfate, iron, and TDS than groundwater in the sandier units of the Calvert Bluff. The low vertical permeability of the Calvert Bluff Formation prevents the groundwater in the reclaimed spoil from migrating downward into the Simsboro aquifer. Mixing of groundwater in the reclaimed spoil with groundwater in the adjacent Calvert Bluff can occur locally near some of the reclaimed spoil. However, the mixing zone is generally small and located immediately downgradient of the reclaimed spoil (Pollock 1982).

Hydraulic Properties and Groundwater Movement

The groundwater gradient in the Simsboro aquifer is to the southeast at approximately 0.0023 feet/feet. The range in groundwater elevation is from approximately 540 feet National Geodetic Vertical Datum (NGVD) in the Simsboro outcrop area west of the Three Oaks Mine to 325 feet NGVD near Paige, Texas. The average porosity of the Simsboro sands is approximately 20 percent. The results of aquifer tests (Alcoa 2000 [Volume 4]) in the Three Oaks Mine area are summarized in **Table C-3**. Based on the results of these tests, the Simsboro aquifer has transmissivities in the range of 911 to 1,742 feet squared per day and hydraulic conductivities ranging from 11.2 to 26 feet per day. The specific yield of the aquifer is approximately 0.15 to 0.20, and the storage coefficient for the artesian section of the aquifer is in the range of 0.0001 to 0.0004. Regionally, the Simsboro has hydraulic conductivities in the range of 15 to 54 feet per day and transmissivities in excess of 2,680 feet squared per day. The Simsboro in the permit area is thus somewhat less transmissive than other parts of the aquifer within the Carrizo-Wilcox aquifer system. Groundwater in the Simsboro aquifer moves to the southeast at a rate of approximately 0.2 feet per day (using the average gradient), a porosity of 20 percent, and an average hydraulic conductivity of 18 feet per day. Thus, over a period of 1 year, groundwater moves approximately 73 feet.

The Calvert Bluff aquifer (upper, 200 lignite zone, and 800 lignite zone) does not have a consistent water table or potentiometric surface due to the poor lateral continuity of the sand channels and low vertical hydraulic conductivity of confining zones (**Figures C-7, C-8,** and **C-9** respectively). Groundwater levels range from 420 to 480 feet NGVD in the upper Calvert Bluff Formation (approximately the upper 100 feet) in the permit area, including the outcrop of the formation, to levels of 300 to 450 feet NGVD downgradient to the southeast near Paige, Texas. There is no consistent pattern to the measured water levels, because the groundwater is found mainly in the channel sand units.

The porosity of the Calvert Bluff varies considerably. Sand units have porosities of approximately 20 percent, and the clay and silty clay that dominate the formation have porosities ranging from 30 to 50 percent (Fetter 1994). Aquifer tests in the Calvert Bluff (Alcoa 2000 [Volume 4]) have indicated transmissivities of 0.005 to 12.7 feet squared per day for more clayey materials units, 7.8 to 101.4 feet squared per day for silt and silty sand units, and 288 to 372 feet squared per day for sand channel units. Hydraulic conductivities ranged from up to 1.5 feet per day for more clayey materials, from 0.4 to 4.0 feet per day for silt and silty sand units, and from 5.4 to 6.3 feet per day for sand channel units. Specific yields for the Calvert Bluff sand units are in the range of 0.01 to 0.2, and the confined storage coefficient ranges from 0.0001 to 0.01. Groundwater in the artesian portion of the Calvert Bluff moves very slowly to the southeast under an estimated gradient of approximately 0.001 feet/feet. A rough estimate of the average

groundwater velocity is approximately 0.025 feet per day, using the average gradient, a porosity of 20 percent, and an average hydraulic conductivity of approximately 5.0 feet/day. Over a period of 1 year, groundwater would therefore move approximately 9 to 10 feet.

The Carrizo aquifer has not been studied in detail in the study area. The regional properties of the Carrizo aquifer are presented earlier in this section.

Groundwater Quality

Groundwater quality in the permit area and in immediately adjacent areas is quite variable and depends on the aquifer and whether the well is screened in sand or silt and clay. Groundwater samples taken in and adjacent to the permit area are presented in the Railroad Commission of Texas (RRC) Three Oaks Mine Permit Application (Alcoa 2001b [Volume 2]).

For the Calvert Bluff aquifer, groundwater quality varies in the sand channels and the intervening deltaic clays and silts. TDS varies in the Calvert Bluff from 1,400 to 5,700 mg/l. Most samples have concentrations above 3,000 mg/l. The lower ranges for TDS are from samples taken in sand channels in the Calvert Bluff. Calcium ranges from 250 to 800 mg/l, and sodium ranges from 200 to 500 mg/l. Bicarbonate ranges from 200 to 600 mg/l, while sulfate ranges from 100 to 2,000 mg/l with most samples in the range of 200 to 2,000 mg/l. Thus, most groundwater in the Calvert Bluff is dominated by calcium or calcium plus sodium sulfate. Some groundwater from the sand channels is bicarbonate-dominated. Chloride also is high in the Calvert Bluff, ranging from 100 to 2,000 mg/l. The pH of groundwater in the Calvert Bluff ranges from 3.6 to 8 standard units with most values falling in the range of 6 to 8 standard units. Iron is very high in the Calvert Bluff, with total iron ranging from 1 to 1,000 mg/l and generally in the range of 5 to 50 mg/l. Manganese ranges up to 11 mg/l. Thus, groundwater in the Calvert Bluff is highly variable and can be somewhat acidic with high iron and sulfate, or can be near neutral and be calcium bicarbonate water. For the most part, however, groundwater in the Calvert Bluff is mineralized and generally not suitable for domestic use without treatment. Groundwater from the sand channels and from areas generally removed from the lignite beds can be suitable for irrigation and livestock use. Trace metals are low in groundwater from the Calvert Bluff, except for iron and manganese.

Groundwater in the Simsboro aquifer is generally of good quality and mostly calcium bicarbonate water with TDS usually below 500 mg/l. The range in TDS for the Simsboro is 100 to 800 mg/l. Sulfate is generally less than 125 mg/l as is chloride. Calcium is dominant over sodium, and bicarbonate ranges from 100 to 300 mg/l. Iron ranges from 1 to 7 mg/l, making the water somewhat iron rich. Manganese is less than 1 mg/l. Other trace metals in the Simsboro are low.

Groundwater in the Carrizo aquifer also is of good quality and suitable for domestic consumption. TDS ranges from 300 to 700 mg/l. Sulfate is mostly below 100 mg/l but ranges from 60 to 300 mg/l. Chloride is mostly between 30 and 50 mg/l but can be up to 197 mg/l. Sodium dominates over calcium, with sodium ranging from 60 to 393 mg/l and calcium generally below 100 mg/l. Bicarbonate ranges from 200 to 765 mg/l, making the groundwater in the Carrizo aquifer sodium-bicarbonate-dominated. Trace metals are low in the Carrizo aquifer.

Regional Surface Water Quality

Dissolved barium was typically less than detection limits at sites near the Sandow Mine, but ranged from 37 to 300 mg/l at the U.S. Geological Survey (USGS) sites. Dissolved iron values typically were less than 200 mg/l. Higher iron values, up to 1,200 mg/l, occurred on Big Sandy Creek near Elgin (Station 08159170). Dissolved manganese values ranged from less than 0.01 to 1.99 mg/l in the Sandow Mine area, and up to 5,400 mg/l on Big Sandy Creek near McDade (Station 08159165). TDS were generally less than 1,000 mg/l, and pH ranged from 6.1 to 8.3 standard units. Higher TDS values were recorded upstream from the Sandow Mine, ranging to over 3,000 mg/l (Alcoa 1999).

Hardness as calcium carbonate ranged from approximately 30 to 200 mg/l, with still higher values (up to 480 mg/l) occurring on East Yegua Creek near Dime Box (Station 08109800). Baseline chloride and sulfate levels at both USGS stations on Big Sandy Creek were usually within the criteria for the nearest classified segment downstream (Colorado River above LaGrange), although the chloride level near McDade exceeded that criteria twice. Electrical conductivity values ranged widely, from approximately 150 to over 2,000 microsiemens per centimeter (a siemen per meter is a unit of electrical conductivity in the Systeme International [SI] measurement system). Higher values were most common on East Yegua Creek, but they also were present on Big Sandy Creek near McDade. Sodium and sodium adsorption ratio were low, generally ranging from 1.0 to 2.5. Dissolved oxygen levels were greater than both annual average and seasonal criteria for the aquatic life uses at all USGS stations.

Suspended sediment content (as tons per day) was sampled at the USGS stations during periods of both high and low flows. The values ranged widely and were dependent on watershed conditions, the season, flow conditions at the time of sampling (rising, steady, or falling flows), and other sources of variation. In general, lower values were associated with lower flow rates. Some high values were recorded on both Big Sandy Creek and East Yegua Creek. On Big Sandy Creek near McDade, 2,340 tons per day and 3,260 tons per day were recorded in March and May of 1980, respectively. Approximately 1,665 tons per day were recorded concurrently on Big Sandy Creek near Elgin. During 1975 on East Yegua Creek, a suspended sediment yield of 5,630 tons per day was recorded at a water flow rate of 14,000 cubic feet per second (cfs).

GROUNDWATER TABLES

Table C-1
Hydraulic Properties of the Carrizo-Wilcox Aquifer System in East-central Texas

Aquifer	Pumping Rate (gpm)	Specific Capacity Range[1] (gpm/foot)	Storage Coefficient[1] (range)	Average of Storage Coefficient[1]	Transmissivity Range (feet^2/day)	Average Transmissivity (feet^2/day)	Horizontal Hydraulic Conductivity Range (feet/day)	Average Horizontal Hydraulic Conductivity (feet/day)
Carrizo-Wilcox	391 – 1,105	5.5 – 9.5	0.0000124(1)	0.0000124(1)	1,049 – 8,710	2,616	7 – 21	12
Carrizo	11 – 1,650	0.7 – 28.6	0.00016(1)	0.00016(1)	2,425 – 18,027	6,498	26 – 140	75[2]
Wilcox (undifferentiated)	12 – 618	0.5 – 17.7	0.00083 – 0.0012	0.00099(3)	121 – 14,070	3,415	2 – 204	31
Calvert Bluff	60 – 445	1.0 – 1.5 (2)	--	--	429 – 2,150	1,289	4 – 18	11
Simsboro	50 – 2,700	1.3 – 32.0	0.00034 – 0.034	0.0016(6)	147 – 24,452	4,639	2 – 84	24
Hooper	35 – 500	0.5 – 3.5	--	--	112 – 2,277	543	1 – 34	7[3]

[1]Numbers in parenthesis indicate the number of tests used to determine the values.
[2]Average hydraulic conductivity is 64 excluding one abnormally high value (140).
[3]Average hydraulic conductivity is 2 excluding one abnormally high value (34).

Source: Thorkildson and Price 1991.

Table C-2
Water Quality of the Carrizo-Wilcox Aquifer System in East-central Texas[1]

Constituents		Carrizo Aquifer	Calvert Bluff Aquifer	Simsboro Aquifer	Hooper Aquifer	Wilcox Group Undifferentiated Aquifer System
Silica	Mean	21	27	28	28	25
	Range	1-114	1-117	5-58	2-71	5-100
Iron	Mean	2.65	4.89	1.94	1.92	2.19
	Range	0.0-73.0	0.0-73.0	0.0-49.5	0.0-20.0	0.0-46.0
Calcium	Mean	27	51	35	57	61
	Range	0-493	1-436	0-233	2-327	0-820
Magnesium	Mean	6	14	7	14	18
	Range	0-136	0-144	0-70	0-105	0-369
Sodium	Mean	133	105	100	103	160
	Range	2-2,362	10-1,670	5-686	14-350	2-1,510
Potassium	Mean	9	4	4	4	4
	Range	0.3-475	0.1-13	1-19	0.9-40	0-23
Bicarbonate	Mean	276	262	241	254	300
	Range	0-1,610	8-1,260	16-1,087	0-590	0-2,080
Carbonate	Mean	2	1	4	<1	1
	Range	0-56	0-33	0-436	0-19	0-53
Sulfate	Mean	55	80	49	60	103
	Range	0-1,600	0-1,640	0-2,000	0-533	0-1,800
Chloride	Mean	74	104	80	118	167
	Range	3-4,000	5-3,480	6-810	5-1,160	3-1,940
Fluoride	Mean	<1	<1	<1	<1	<1
	Range	0-8	0-3	0-2	0-1	0-6
Nitrate (NO_3) or	Mean	1.6	2.7	1.3	6.3	7.4
Nitrate (as N)	Range	0-83	0-144	0-21	0-128	0-540
Boron	Mean	0.22	0.28	.16	0.14	0.34
	Range	0-1.9	0.01-2.3	0-0.5	0-0.6	0-1.6
Total dissolved solids	Mean	464	470	403	506	648
	Range	41-6,700	136-2,641	78-1,692	0-2,214	27-5,211
Hardness (as $CaCO_3$)	Mean	91	216	132	215	231
	Range	1-1,790	5-2,840	2-1,900	0-3,000	3-3,483
Sodium (percent)	Mean	70	54	55	54	59
	Range	9-99	10-99	10-99	4-98	5-99
Sodium adsorption	Mean	12.9	6.5	9.5	4.7	10.3
ratio (SAR)	Range	0.2-99.7	0.6-63.4	0.4-73.4	0.5-29.2	0.1-142.4
Residual sodium	Mean	3.4	2.2	2.6	1.3	2.5
carbonate	Range	0-26	0-20.2	0-16.9	0-6.4	0-32.2
Specific conductance	Mean	731	792	660	854	1062
(micromhos at 25°C)	Range	57-14,250	101-11,200	90-2,900	194-5,570	92-7,784
pH (standard units)	Mean	7.4	7.6	7.4	7.6	7.7
	Range	3.3-9.7	5.1-8.7	5.3-9.4	5.5-8.8	4.8-9.5

[1]Only analyses that were representative of native groundwater were used. Data are presented in milligrams per liter except percent sodium, specific conductance, pH, and SAR.

Source: Thorkildson and Price 1991.

Table C-3
Summary of Aquifer Properties in the Three Oaks Mine Area

Test Site	Aquifer Tested	Formation Thickness (feet)	Pumping Rate (gpm)	Transmissivity ($feet^2$/day)	Horizontal Hydraulic Conductivity (feet/day)	Storage Coefficient	Test Type
K2444A	Calvert Bluff	22	0.97	12.7	0.58	--	Slug test
K2741B	Calvert Bluff	27	--	50.9	1.88	0.0097	Constant rate
K2842B	Calvert Bluff	19	--	7.77	0.4	--	Slug test
K3133A	Calvert Bluff	29	--	1.6	0.05	--	Slug test
K3244B	Calvert Bluff	26	9	101.4	3.89	0.00045	Constant rate
K3924A	Calvert Bluff	27	--	12.3	0.45	--	Slug test
K4326A	Calvert Bluff	15	--	0.005	0.00027	--	Slug test
K4426A	Calvert Bluff	28	--	2	0.067	--	Slug test
K4535B	Calvert Bluff	46	9.8	36.4	0.79	0.000099	Constant rate
K4631A	Calvert Bluff	59	18.5	371.8	6.3	0.045	Constant rate
K5122A	Calvert Bluff	31	10.7	102.2	3.35	0.00027	Constant rate
K5726A	Calvert Bluff	54	28.9	288.1	5.36	0.00025	Constant rate
K2741J	Simsboro	67	256	1742	26	0.0001	Constant rate
K3244G	Simsboro	81	374	911.2	11.26	0.00036	Constant rate

Source: Alcoa 2000 (Volume 4).

Table C-4
Hydraulic Properties of the Calvert Bluff and Simsboro Aquifers at the Sandow Mine

Well Number	Pumping Rate (gpm)	1-Hour Specific Capacity (gpm/feet)	Net Sand Thickness (feet)	Transmissivity ($feet^2$/day)	Horizontal Hydraulic Conductivity (feet/day)	Storage Coefficient
Calvert Bluff Aquifer						
OB-6	1	--	50	10.05	0.2	--
A37-8-1	15	--	29	107.2	3.75	0.0005
OB-47	--	--	30	61.6	2.01	--
OB-48P	55	--	53	107.2	20.1	0.0002
F38-10	40	--	29	589.6	20.1	--
OB-25	65	--	22	670	30.8	--
OB-H2-93P	36	--	100	938	9.4	--
I3462	70	--	65	415.4	6.4	--
AX2172A	75	--	60	1,105.5	17.4	--
C4745A	10	--	45	268	4.0	--
Simsboro Aquifer						
F38-5-CBUS	5.5	0.15	25	38.9	1.55	--
NFD-04 (F-1)	870	6.80	150	2,197.6	14.6	0.0003
UB-20	--	--	5	0.9	0.18	0.00001
G30-15-CBUS	46	0.86	40	234.1	5.9	0.00005
G38-20 (C)	65	0.87	50	--	--	--
G38-20 (S)	82	3.25[1]	30	--	--	--
G4-DP-Sims	1,200	12.50	185	5,896	31.9	0.0004
H11-10	100	3.13[1]	45	--	--	--
H19-1-CBUS	--	--	15	1.88	0.12	0.00005
H1 Sims DP	1,190	--	--	3,283	--	--
H(9)-2	515	6.8	220	3,122.2	14.2	--
P-1 thru P-6	8,800	--	--	6,164	--	0.00058
P-1	1,594	11	140	3,618	25.9	--
P-2	2,704	20	183	5,628	30.8	--
P-3	2,388	14	126	4,690	37.2	--
P-4	2,817	32	152	6,298	41.4	--
P-6	2,065	28	206	7,102	34.4	0.0008
UB-2A	86	--	175	5,226	29.5	0.00072
DP-S-A-4	600	8	111	7,008	31.9	--
DP-A2R	1,350	39	121	7,892	65.3	--

[1]Representative of only the upper sands of the Simsboro.

Source: Hall Southwestern Water Consultants 1985; RWHA 1999.

Table C-5
Groundwater Quality at the Sandow Mine

Constituent	Calvert Bluff Aquifer			Simsboro Aquifer			Reclaimed Spoil Groundwater		
	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
pH (standard units)	4.84	7.77	6.6	4.6	8.2	6.48	5.5	7.7	6.4
TDS (mg/l)	348	3,800	487	104	890	348	1,108	6,570	3,925
Sulfate (mg/l)	16	1,148	308	1	154	45	240	2,400	1,176
Iron (dissolved) (mg/l)	<.05	21.7	4.86	<.05	16.7	3.72	0.17	22.6	11.76
Manganese (dissolved) (mg/l)	0.06	1.85	0.67	0.01	1.05	0.22	0.02	7.91	4.15

Source: RWHA 1999.

SURFACE WATER TABLES

Table C-6
Mean Monthly Flow at Regional USGS Stream Gages
(cfs)

Month	Middle Yegua Creek (08109700[1])	East Yegua Creek (08109800[1])	Big Sandy near McDade (08159165[1])	Big Sandy near Elgin (08159170[1])	Brushy Creek at Rockdale (08106300[1])	Yegua Creek at Somerville (08110000[1])	Colorado River at Bastrop (08159200[1])
January	64.9	70.5	3.41	4.31	260	301	1,671
February	85.9	99.1	5.65	6.30	260	394	2,107
March	63.1	76.6	13.1	15.9	258	307	2,307
April	55.8	73.2	1.71	2.13	347	416	2,502
May	113	119	23.1	32.5	466	529	3,423
June	97.3	107	29.6	38.5	171	358	4,463
July	7.01	17.6	0.92	0.85	115	282	2,587
August	2.48	8.59	0.30	0.81	20.8	75.1	1,879
September	16.5	23.2	0.15	0.81	83.5	106	1,716
October	33.9	42.6	13.2	14.2	136	177	1,429
November	51.8	52.0	8.76	9.82	127	206	1,232
December	80.3	78.2	5.43	5.17	140	259	1,462
Yearly	**56.0**	**64.0**	**8.8**	**10.8**	**199**	**284**	**2,232**

[1]Stream gage identification number.

Note: The data shown are for substantially different periods of record, as identified in Section 3.2.1.3, Surface Water. The data are shown for illustrative purposes only; this particularly applies to the Big Sandy Creek and Brushy Creek stations. East Yegua Creek flows historically have been augmented to some degree by pumping discharges from the Sandow Mine.

Source: USGS 2001.

Table C-7
Flow Characteristics on Middle Yegua Creek Near Dime Box
(cfs)

1Month	Monthly Mean Flow	Lowest Recorded Flow	Highest Recorded Flow
January	64.9	0.006	481
February	85.9	0.007	891
March	63.1	0.65	280
April	55.8	0.72	308
May	113	0.00	662
June	97.3	0.00	1,052
July	7.01	0.00	67.7
August	2.48	0.00	18.2
September	16.5	0.00	368
October	33.9	0.00	245
November	51.8	0.00	528
December	80.3	0.00	694

Note: Monthly low flows did not all occur in a single year, nor did monthly high flows. Period of record is 8/62 to 9/00.

Source: USGS 2001.

Table C-8
Average Sandow Mine Pumpage Discharges[1]

Discharge Rate	January	February	March	April	May	June	July	August	September	October	November	December
Acre-feet	1,671	1,559	1,687	1,647	1,663	1,635	1,685	1,700	1,678	1,740	1,744	1,713
Cubic feet per second	27.2	28.1	27.4	27.7	27.0	27.5	27.4	27.6	28.2	28.3	29.3	27.9

[1]Values are estimates for the period 1993 to 2001, based on Sandow well field pumping history and a consumption of 5,000 acre-feet per year at the Sandow facilities. The remaining surpluses are discharged in accordance with Texas Natural Resource Conservation Commission (TNRCC) regulations to Walleye Creek (a tributary of Middle Yegua Creek) and to East Yegua Creek.

Table C-9
Baseline Inventory Flow Data in the Three Oaks Mine Vicinity

Dates	Surface Water Monitoring Stations[1] and Flow Rates (cfs)									
	LLS	UBS	LBS	LMY	LMC	LWC	UWC	CC	LC	I3
1999										
April	1.32	no data	1.28	0.99	0.02	0.00	no data	0.00	0.00	0.00
May	0.75	0.08	0.62	0.64	0.00	0.00	0.00	0.00	0.00	0.00
June	0.65	0.04	0.74	0.62	0.00	0.00	0.00	0.00	0.00	0.00
July	0.61	<0.01	<0.01	3.49	0.00	0.00	0.00	0.00	0.00	0.00
August	0.28	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
September	0.13	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
October	0.45	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
November	no data	no data	no data	no data	no data	no data	no data	no data	0.00	0.00
December	0.43	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000										
January	1.31	<0.01	0.35	0.04	0.00	0.00	0.00	0.00	0.00	0.00
February	0.71	0.03	0.28	0.13	0.00	0.00	0.00	0.00	0.00	0.00
March	1.81	0.05	5.92	1.17	0.00	0.00	0.00	0.00	0.00	0.00
April	0.46	0.02	0.45	0.07	0.00	0.00	0.04	0.00	0.00	0.00
May	0.42	0.03	0.38	0.17	0.00	0.00	0.00	0.00	0.00	0.00
June	0.52	0.05	0.77	0.09	0.00	0.00	0.00	0.00	0.00	0.00
July	0.28	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
August	0.22	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
September	0.26	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
October	0.72	0.02	0.74	0.14	0.00	0.00	0.00	0.00	0.00	0.00
November	UTM[2]	0.06	7.48	9.34	3.58	UTM[2]	0.40	0.44	UTM[2]	0.00
December	1.90	0.03	1.50	0.83	0.10	0.11	0.00	0.03	0.00	0.00
2001										
January	10.10	0.29	10.64	15.50	1.67	1.67	1.30	0.44	0.00	0.00
February	6.68	0.07	5.10	1.37	0.35	<0.01	<0.01	0.11	0.00	0.00
March	UTM[2]	0.14	4.22	3.35	1.60	0.11	0.09	0.01	0.00	UTM[2]
April	3.30	0.03	2.54	4.40	0.03	0.00	0.00	0.00	0.00	0.00

[1]See Figure 3.2-21 for surface water monitoring station locations.
LLS = Lower Little Sandy Creek
UBS = Upper Big Sandy Creek
LBS = Lower Big Sandy Creek
LMY = Lower Middle Yegua Creek
LMC = Lower Mine Creek
LWC = Lower Willow Creek
UWC = Upper Willow Creek
CC = Chocolate Creek
[2]Unable to measure due to very low flow.

Note: Data represents instantaneous point measurements during the month indicated; not monthly average/lows.

Source: Alcoa 2001b (Volume1).

Table C-10
Surface Water Criteria for Classified Stream Segments

Constituent	Somerville Lake (Segment 1212)	Colorado River above LaGrange (Segment 1434)
Chloride (mg/l)	100	100
Sulfate (mg/l)	100	100
Total dissolved solids (mg/l)	400	500
Dissolved oxygen (mg/l)	5.0	6.0
pH (standard units)	6.5 - 9.0	6.5 - 9.0
Indicator bacteria (number per 100 milliliters)	126/200	126/200
Temperature (°F)	93	95
Biochemical oxygen demand[1] (mg/l)	no data	5
Total suspended solids[1] (mg/l)	no data	5
Ammonia-N[1] (mg/l)	no data	2
Total phosphorus[1] (mg/l)	no data	1

[1]Based on a 30-day average.

Source: TAC 2000a; 1986.

Table C-11
Surface Water Criteria for Selected Toxic Constituents[1]
(mg/l)

Constituent[2]	Brazos River Basin			Colorado River Basin		
	Aquatic Life - Toxic	Aquatic Life - Chronic	Human Health[3]	Aquatic Life - Toxic	Aquatic Life - Chronic	Human Health[3]
Aluminum, d	991	--	--	991	--	--
Arsenic, d	360	190	50	360	190	50
Barium, d	--	--	2,000	--	--	2,000
Cadmium, d	44.9	3.2	5	48.1	3.3	5
Chromium III, d	414	197	100[4]	435	207	100[4]
Chromium V, d	15.7	10.6	--	15.7	10.6	--
Copper, d	31.0	22.4	--	32.9	23.6	--
Lead, d	88.6	1.3	4.98	95.7	1.4	4.98
Mercury, t	2.4	1.3	0.0122	2.4	1.3	0.0122
Nickel, d	1,255	195.5	--	1321	205.8	--
Selenium, t	20	5	50	20	5	50
Zinc, d	149.5	138.5	--	157.3	145.8	--

[1]Values are for protection of the uses shown, with an assumed water-effects ratio of 1.0.
[2]d = dissolved, t = total.
[3]Public water supplies are assumed to exist in the study area.
[4]Form not specified for chromium.

Source: TAC 2000a.

Table C-12
Water Quality Analyses for Area Streams
(Period: April 1999 - April 2001)

Baseline Stream Monitoring Station ID[1]	Field Measurements				Laboratory Analyses						
	pH (standard units)	Conductivity (umhos/cm)	Dissolved Oxygen (mg/l)	Temp (°C)	pH (standard units)	Acidity (mg/l)	Alkalinity (mg/l)	Fluoride (mg/l)	Hardness (mg/l)	Ammonia (N)(mg/l)	Oil and Grease (mg/l)
Minimum											
CC	6.28	89	2.78	10.1	6.4	< 1	8	< 0	36	0.2	< 5
LBS	6.25	244	2.39	8.4	6.7	< 1	54	0	115	< 0.1	< 5
LC	7.15	54	5.34	20.6	7.2	< 1	23	0	22	< 0.1	< 5
LLS	6.12	390	2.56	9.1	6.4	< 1	32	< 0	127	< 0.1	< 5
LMC	6.45	218	2.85	7.5	7.1	< 1	29	0	126	0.2	< 5
LMY	6.11	241	2.8	7.1	7.0	< 1	41	0	72	< 0.1	< 5
LWC	6.95	130	1.14	8.6	7.4	< 1	33	0	50	0.1	< 5
UBS	6.49	206	1.42	7.1	6.7	< 1	45	0	67	< 0.1	< 5
UWC	6.89	8	2.65	10.9	6.7	< 1	14	< 0	27	0.1	< 5
Maximum											
CC	7.06	2050	12.72	20.3	7.5	10	32	0	726	0.8	< 5
LBS	8.21	1001	10.31	29	8.2	< 1	151	1	369	2.3	7
LC	7.15	54	5.34	20.6	7.2	< 1	23	0	22	< 0.1	< 5
LLS	7.86	1070	9.93	29.8	8.3	< 1	136	0	333	0.8	6
LMC	7.53	1870	11.26	23.1	7.9	< 1	69	0	755	0.9	< 5
LMY	8.83	1210	10.75	31.3	8.4	< 1	173	1	453	0.7	< 5
LWC	7.22	860	11.39	27.1	8.2	< 1	77	0	310	0.6	< 5
UBS	8.12	715	9.7	31.5	8.2	< 1	94	1	156	1.4	8
UWC	7.45	624	13.31	21.4	8.3	3	81	0	224	0.7	9
Average											
CC	6.76	1059	8.94	13.30	7.1	3	21	0	383	0.43	< 5
LBS	7.40	691	6.64	20.14	7.7	< 1	89	0	212	0.33	< 5
LC	7.15	54	5.34	20.60	7.2	< 1	23	0	22	< 0.1	< 5
LLS	6.94	674	5.62	20.55	7.5	< 1	66	0	181	0.19	< 5
LMC	6.94	1044	6.90	17.24	7.6	< 1	49	0	387	0.47	< 5
LMY	7.27	746	6.96	21.04	7.8	< 1	102	0	240	0.26	< 5
LWC	7.10	481	7.34	17.94	7.7	< 1	57	0	160	0.26	< 5
UBS	7.30	470	4.63	20.00	7.6	< 1	79	0	136	0.28	< 5
UWC	7.13	176	8.11	15.30	7.5	1	47	0	101	0.32	< 5

Table C-12 (Continued)

Baseline Stream Monitoring Station ID	Laboratory Analyses										
	Conductivity (umhos/cm)	Settleable Solids (mg/l)	Total Dissolved Solids (mg/l)	Total Suspended Solids (mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Potassium (mg/l)	Sodium (mg/l)	Bicarbonate (mg/l)	Carbonate (mg/l)	Chloride (mg/l)
Minimum											
CC	132	< 0.5	130	23	10	3	5	2	9	<1	4
LBS	321	< 0.5	260	8	34	8	6	21	65	<1	46
LC	59	< 0.5	60	4	6	2	6	1	28	<1	3
LLS	415	< 0.5	322	< 4	35	9	6	31	38	<1	66
LMC	364	< 0.5	260	7	32	11	6	23	35	<1	42
LMY	227	< 0.5	210	9	19	6	6	14	49	<1	27
LWC	119	< 0.5	120	16	14	4	6	4	40	<1	4
UBS	219	< 0.5	170	< 4	19	5	3	16	55	<1	31
UWC	66	< 0.5	50	20	6	2	5	2	17	<1	4
Maximum											
CC	1740	< 0.5	1680	152	207	51	7	161	38	< 1	256
LBS	1300	< 0.5	970	100	108	24	9	102	184	< 1	220
LC	59	< 0.5	60	4	6	2	6	1	28	< 1	3
LLS	1250	0.5	1060	62	99	21	10	101	166	< 1	212
LMC	2180	< 0.5	1860	84	197	64	12	158	84	< 1	277
LMY	1480	< 0.5	1230	259	131	31	11	110	211	5	202
LWC	727	< 0.5	650	78	88	22	7	56	94	< 1	129
UBS	556	< 0.5	440	213	43	12	8	43	114	< 1	96
UWC	573	< 0.5	460	1008	64	16	7	32	99	< 1	68
Average											
CC	1034	< 0.5	873	75	109	27	7	79	25	< 1	131
LBS	686	< 0.5	502	40	61	15	7	55	109	< 1	117
LC	59	< 0.5	60	4	6	2	6	1	28	< 1	3
LLS	683	< 0.5	509	12	50	14	8	59	80	< 1	130
LMC	1102	< 0.5	889	36	100	33	8	83	60	< 1	147
LMY	739	< 0.5	550	56	67	18	8	58	124	< 1	120
LWC	423	< 0.5	348	43	44	12	6	30	69	< 1	59
UBS	460	< 0.5	328	29	37	11	5	35	96	< 1	81
UWC	264	< 0.5	216	227	29	7	6	13	57	< 1	27

Table C-12 (Continued)

Baseline Stream Monitoring Station ID	Laboratory Analysis			Total Metals							
	Nitrate (N)(mg/l)	Nitrite (N)(mg/l)	Sulfate (mg/l)	Aluminum (mg/l)	Arsenic (mg/l)	Barium (mg/l)	Cadmium (mg/l)	Chromium (mg/l)	Iron (mg/l)	Lead (mg/l)	Manganese (mg/l)
Minimum											
CC	0.1	< 0.1	7	1.00	< 0.005	0.06	< 0.001	< 0.02	1.49	< 0	0.02
LBS	< 0.1	< 0.1	37	0.10	< 0.005	0.09	< 0.001	< 0.02	0.53	< 0	0.17
LC	< 0.1	< 0.1	3	1.20	< 0.005	0.05	< 0.001	< 0.02	1.07	< 0	< 0.01
LLS	< 0.1	< 0.1	32	< 0.10	< 0.005	0.1	< 0.001	< 0.02	0.35	< 0	0.14
LMC	< 0.1	< 0.1	93	< 0.20	< 0.005	0.08	< 0.001	< 0.02	1.87	< 0	0.24
LMY	< 0.1	< 0.1	15	0.30	< 0.005	0.08	< 0.001	< 0.02	1.02	< 0	0.10
LWC	< 0.01	< 0.1	3	0.07	< 0.005	0.06	< 0.001	< 0.02	1.76	< 0	0.06
UBS	< 0.1	< 0.1	14	< 0.20	< 0.005	0.08	< 0.001	< 0.02	0.15	< 0	0.18
UWC	0.1	< 0.1	5	1.10	< 0.005	0.06	< 0.001	< 0.02	1.12	< 0	0.03
Maximum											
CC	0.3	< 0.1	697	2.8	< 0.005	0.08	0.001	< 0.02	7.94	< 0	3.49
LBS	65	0.1	103	4.9	< 0.005	0.19	0.001	< 0.02	5.38	< 0	1.52
LC	< 0.1	< 0.1	3	1.2	< 0.005	0.05	< 0.001	< 0.02	1.07	< 0	< 0.01
LLS	11.2	0.2	106	3.3	< 0.005	0.2	< 0.001	< 0.02	4.54	< 0	1.34
LMC	0.3	< 0.1	623	3.4	< 0.005	0.18	< 0.001	< 0.02	6.91	< 0	9.26
LMY	0.5	0.2	210	7.1	< 0.005	0.18	< 0.001	< 0.02	7.79	< 0	1.46
LWC	0.3	< 0.1	189	5.3	< 0.005	0.24	< 0.001	< 0.02	6.75	< 0	2.55
UBS	0.5	< 0.1	38	4.2	< 0.005	19	0.004	< 0.02	6.48	< 0	1.32
UWC	87	< 0.1	102	18.3	< 0.005	0.26	< 0.001	0.03	12.8	0	1.03
Average											
CC	0.2	< 0.1	363	1.82	< 0.005	0.07	< 0.001	< 0.02	4.66	< 0	1.612
LBS	4.2	< 0.1	75	1.58	< 0.005	0.14	< 0.001	< 0.02	2.02	< 0	0.567
LC	< 0.1	< 0.1	3	1.20	< 0.005	0.05	< 0.001	< 0.02	1.07	< 0	< 0.01
LLS	5.4	< 0.1	51	0.44	< 0.005	0.13	< 0.001	< 0.02	1.93	< 0	0.465
LMC	0.1	< 0.1	304	1.49	< 0.005	0.13	< 0.001	< 0.02	3.82	< 0	3.540
LMY	0.2	< 0.1	92	2.15	< 0.005	0.13	< 0.001	< 0.02	3.17	< 0	0.640
LWC	0.1	< 0.1	83	2.05	< 0.005	0.12	< 0.001	< 0.02	3.41	< 0	0.770
UBS	0.1	< 0.1	21	0.63	< 0.005	0.98	< 0.001	< 0.02	1.87	< 0	0.632
UWC	17.6	< 0.1	43	5.24	< 0.005	0.15	< 0.001	< 0.02	4.28	0	0.370

Table C-12 (Continued)

Baseline Stream Monitoring Station ID	Total Metals					Dissolved Metals			
	Mercury (mg/l)	Molybdenum (mg/l)	Nickel (mg/l)	Selenium (mg/l)	Zinc (mg/l)	Aluminum (mg/l)	Arsenic (mg/l)	Barium (mg/l)	Cadmium (mg/l)
Minimum									
CC	< 0.001	< 0.05	< 0.10	< 0.005	< 0.02	< 0.1	< 0.005	0.06	< 0
LBS	< 0.001	< 0.05	< 0.05	< 0.005	< 0.02	< 0.1	< 0.005	0.01	< 0
LC	< 0.001	< 0.05	< 0.10	< 0.005	< 0.02	0.6	< 0.005	0.04	< 0
LLS	< 0.001	< 0.05	< 0.05	< 0.005	< 0.02	< 0.1	< 0.005	0.01	< 0
LMC	< 0.001	< 0.05	< 0.05	< 0.005	< 0.02	< 0.1	< 0.005	0.10	< 0
LMY	< 0.001	< 0.05	< 0.05	< 0.005	< 0.02	< 0.1	< 0.005	0.01	< 0
LWC	< 0.001	< 0.05	< 0.10	< 0.005	< 0.02	< 0.1	< 0.005	0.05	< 0
UBS	< 0.001	< 0.05	< 0.05	< 0.005	< 0.02	< 0.1	< 0.005	0.01	< 0
UWC	< 0.001	< 0.05	< 0.05	< 0.005	< 0.02	< 0.1	< 0.005	0.04	< 0
Maximum									
CC	< 0.001	< 0.05	< 0.10	< 0.005	0.08	0.4	< 0.005	0.08	0
LBS	< 0.001	< 0.05	< 0.10	< 0.005	0.05	< 0.2	< 0.005	0.80	0
LC	< 0.001	< 0.05	< 0.10	< 0.005	< 0.02	0.6	< 0.005	0.04	< 0
LLS	< 0.001	< 0.05	< 0.10	< 0.005	0.04	< 0.2	< 0.005	0.20	< 0
LMC	< 0.001	< 0.05	< 0.10	< 0.005	0.03	< 0.2	< 0.005	0.18	< 0
LMY	< 0.001	< 0.05	< 0.10	< 0.005	0.02	0.5	< 0.005	0.17	< 0
LWC	< 0.001	< 0.05	< 0.10	< 0.005	0.03	0.5	< 0.005	0.22	< 0
UBS	< 0.001	< 0.05	< 0.10	< 0.005	0.09	< 0.2	< 0.005	0.20	0
UWC	< 0.001	< 0.05	< 0.10	< 0.005	0.06	0.9	< 0.005	0.22	< 0
Average									
CC	< 0.001	< 0.05	< 0.10	< 0.005	0.045	0.14	< 0.005	0.07	0
LBS	< 0.001	< 0.05	< 0.05	< 0.005	< 0.02	< 0.10	< 0.005	0.16	< 0
LC	< 0.001	< 0.05	< 0.10	< 0.005	< 0.02	0.60	< 0.005	0.04	< 0
LLS	< 0.001	< 0.05	< 0.05	< 0.005	0.022	< 0.10	< 0.005	0.12	< 0
LMC	< 0.001	< 0.05	< 0.05	< 0.005	< 0.02	< 0.10	< 0.005	0.12	< 0
LMY	< 0.001	< 0.05	< 0.05	< 0.005	< 0.02	0.11	< 0.005	0.11	< 0
LWC	< 0.001	< 0.05	< 0.10	< 0.005	< 0.02	0.26	< 0.005	0.10	< 0
UBS	< 0.001	< 0.05	< 0.05	< 0.005	< 0.02	< 0.10	< 0.005	0.14	< 0
UWC	< 0.001	< 0.05	< 0.05	< 0.005	< 0.02	0.32	< 0.005	0.10	< 0

Table C-12 (Continued)

Baseline Stream Monitoring Station ID	Dissolved Metals								
	Chromium (mg/l)	Iron (mg/l)	Lead (mg/l)	Manganese (mg/l)	Mercury (mg/l)	Molybdenum (mg/l)	Nickel (mg/l)	Selenium (mg/l)	Zinc (mg/l)
Minimum									
CC	< 0.02	0.330	< 0.01	0.010	<0.001	< 0.05	< 0.05	< 0.005	< 0.02
LBS	< 0.02	< 0.050	< 0.01	0.140	<0.001	< 0.05	< 0.05	< 0.005	< 0.02
LC	< 0.02	0.340	< 0.01	< 0.010	<0.001	< 0.05	< 0.1	< 0.005	< 0.02
LLS	< 0.02	< 0.050	< 0.01	0.090	<0.001	< 0.05	< 0.05	< 0.005	< 0.02
LMC	< 0.02	< 0.050	< 0.01	0.220	<0.001	< 0.05	< 0.05	< 0.005	< 0.02
LMY	< 0.02	< 0.050	< 0.01	0.090	<0.001	< 0.05	< 0.05	< 0.005	< 0.02
LWC	< 0.02	0.320	< 0.01	0.010	<0.001	< 0.05	< 0.05	< 0.005	< 0.02
UBS	< 0.02	< 0.005	< 0.01	0.170	<0.001	< 0.05	< 0.05	< 0.005	< 0.02
UWC	< 0.02	0.280	< 0.01	0.020	<0.001	< 0.05	< 0.05	< 0.005	< 0.02
Maximum									
CC	< 0.02	0.410	< 0.01	3.370	<0.001	< 0.05	< 0.1	< 0.005	0.08
LBS	< 0.02	0.230	< 0.01	0.920	<0.001	< 0.05	< 0.1	< 0.005	0.12
LC	< 0.02	0.340	< 0.01	< 0.010	<0.001	< 0.05	< 0.1	< 0.005	< 0.02
LLS	< 0.02	0.540	< 0.01	1.280	<0.001	< 0.05	< 0.1	< 0.005	0.04
LMC	< 0.02	1.260	< 0.01	8.180	<0.001	< 0.05	< 0.1	< 0.005	0.14
LMY	< 0.02	0.730	< 0.01	1.360	<0.001	< 0.05	< 0.1	< 0.005	0.05
LWC	< 0.02	0.670	< 0.01	2.510	<0.001	< 0.05	< 0.1	< 0.005	< 0.02
UBS	< 0.02	1.280	< 0.01	1.090	<0.001	< 0.05	< 0.1	< 0.005	0.07
UWC	< 0.02	0.590	< 0.01	0.660	<0.001	< 0.05	< 0.1	< 0.005	0.02
Average									
CC	< 0.02	0.360	< 0.01	1.555	<0.001	< 0.05	< 0.050	< 0.005	0.045
LBS	< 0.02	0.076	< 0.01	0.466	<0.001	< 0.05	< 0.050	< 0.005	< 0.02
LC	< 0.02	0.340	< 0.01	< 0.010	<0.001	< 0.05	< 0.100	< 0.005	< 0.02
LLS	< 0.02	0.124	< 0.01	0.444	<0.001	< 0.05	< 0.050	< 0.005	< 0.02
LMC	< 0.02	0.386	< 0.01	3.349	<0.001	< 0.05	< 0.050	< 0.005	0.029
LMY	< 0.02	0.202	< 0.01	0.566	<0.001	< 0.05	< 0.050	< 0.005	< 0.02
LWC	< 0.02	0.464	< 0.01	0.687	<0.001	< 0.05	< 0.050	< 0.005	< 0.02
UBS	< 0.02	0.259	< 0.01	0.565	<0.001	< 0.05	< 0.050	< 0.005	< 0.02
UWC	< 0.02	0.380	< 0.01	0.268	<0.001	< 0.05	< 0.050	< 0.005	< 0.02

[1]See Figure 3.2-21 for stream monitoring station locations.

Source: Alcoa 2000 (Volume 5).

Table C-13
Surface Impoundment Laboratory Water Quality Results for Samples Collected May 27, 1999 (mg/l unless noted)

Constituents	Surface Pond			
	SI-1	SI-2	SI-3	SI-4
Field Measurements				
pH (standard units)	7.45	7.38	7.31	7.35
Temperature (°C)	27.4	29.2	25.5	27.0
Conductivity (umhos/cm)	37	100	62	69
Dissolved oxygen	6.3	9.4	5.2	5.6
Turbidity (NTU)	216	23	290	283
Laboratory Measurements - General Chemistry				
pH (standard units)	7.1	7.7	7.4	7.0
Acidity	<1	<1	<1	<1
Alkalinity	16	45	31	31
Fluoride	0.1	0.3	0.2	0.1
Ammonia (N)	<0.1	<0.1	<0.1	0.1
Conductivity (umhos/cm)	45	109	70	79
Hardness	21	34	32	35
Settleable solids	<0.5	<0.5	<0.5	<0.5
Total dissolved solids	206	98	148	212
Total settleable solids	40	10	120	43
Nitrite (N)	<0.1	<0.1	<0.1	<0.1
Nitrate (N)	<0.1	<0.1	<0.1	<0.1
Oil and grease	<5	<5	<5	<5
Major Ions				
Calcium	4	8	8	9
Magnesium	3	4	3	3
Potassium	5	11	5	5
Sodium	1	3	2	3
Bicarbonate	20	54	37	37
Carbonate	<1	<1	<1	<1
Chloride	1	4	2	2
Sulfate	1	1	1	3
Dissolved Metals				
Aluminum	1.1	<0.1	0.2	1.4
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	0.03	0.05	0.12	0.14
Cadmium	<0.001	<0.001	<0.001	<0.001
Chromium	<0.02	<0.02	<0.02	<0.02
Iron	0.74	0.48	0.3	0.84
Lead	<0.005	<0.005	<0.005	<0.005
Manganese	<0.01	<0.01	0.03	0.03
Mercury	<0.001	<0.001	<0.001	<0.001
Molybdenum	<0.05	<0.05	<0.05	<0.05
Nickel	<0.05	<0.05	<0.05	<0.05
Selenium	<0.005	<0.005	<0.005	<0.005
Zinc	<0.02	<0.02	<0.02	0.03

Table C-13 (Continued)

Constituents	Surface Pond			
	SI-1	SI-2	SI-3	SI-4
Total Metals				
Aluminum	8.9	0.2	6.3	5.9
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	0.08	0.06	0.13	0.10
Cadmium	<0.001	<0.001	<0.001	0.002
Chromium	<0.02	<0.02	<0.02	<0.02
Iron	7.28	1.13	6.58	5.31
Lead	<0.005	<0.005	0.007	<0.005
Manganese	0.06	0.03	0.14	0.11
Mercury	<0.001	<0.001	<0.001	<0.001
Molybdenum	<0.05	<0.05	<0.05	<0.05
Nickel	<0.05	<0.05	<0.05	<0.05
Selenium	<0.005	<0.005	<0.005	<0.005
Zinc	<0.02	<0.02	<0.02	0.02

Source: Alcoa 2000 (Volume 5).

Table C-14
Surface Impoundment Field Water Quality Data

Surface Impoundment Identification Number	Date Inventoried	Approximate Location (TX-C State Plane) (feet)		Field Water Quality Information			
		Easting	Northing	pH (standard units)	Conductivity (umhos/cm)	Temperature (°C)	Land Owner
SI-1	7/12/1999	2,972,183	270,290	7.70	50	26.9	CPS
SI-2	7/12/1999	2,971,866	270,025	7.15	106	27.9	CPS
SI-3	7/13/1999	2,972,042	269,360	7.50	104	28.4	CPS
SI-4	7/12/1999	2,970,585	270,564	7.56	84	27.4	CPS
SI-5	7/13/1999	2,970,685	269,059	7.68	127	27.6	CPS
SI-6	7/13/1999	2,972,905	272,096	7.41	88	29.4	CPS
SI-7	7/13/1999	2,972,958	272,030	7.43	127	29.8	CPS
SI-8	8/25/1999	2,973,750	269,758	7.48	286	33.2	CPS
SI-9	9/29/1999	2,974,056	269,567	Dry	Dry	Dry	CPS
SI-10	7/9/1999	2,962,297	258,754	6.79	106	26.6	CPS
SI-11	7/9/1999	2,963,170	257,969	7.29	120	27.0	CPS
SI-12	7/9/1999	2,965,353	259,331	Dry	Dry	Dry	CPS
SI-13	7/9/1999	2,965,393	259,878	8.95	183	33.2	CPS
SI-14	7/9/1999	2,964,649	260,855	9.46	142	33.4	CPS
SI-15	7/9/1999	2,966,618	262,211	7.17	129	37.8	CPS
SI-16	7/9/1999	2,966,164	263,093	7.08	117	35.9	CPS
SI-17	4/27/2000	2,981,257	265,868	9.15	99.3	32.9	Private
SI-18	4/17/2000	2,981,244	267,698	8.78	118	29.4	CPS
SI-19	4/17/2000	2,979,536	267,730	9.87	91	31.5	CPS
SI-20	7/19/1999	2,968,198	264,413	8.38	66	33.2	CPS
SI-21	7/13/1999	2,968,513	265,248	Dry	Dry	Dry	CPS
SI-22	7/13/1999	2,966,911	265,852	7.57	132	28.6	CPS
SI-23	7/13/1999	2,969,853	266,569	8.11	129	32.2	CPS
SI-24	7/13/1999	2,971,441	266,730	9.19	69	32.5	CPS
SI-25	7/13/1999	2,972,442	267,396	7.83	152	30.8	CPS
SI-26	7/12/1999	2,969,497	268,285	7.61	133	28.3	CPS
SI-27	7/23/1999	2,967,970	269,218	7.72	152	31.2	CPS
SI-28	7/13/1999	2,972,889	272,162	7.52	133	29.6	CPS
SI-29	8/6/1999	2,974,036	268,878	Dry	Dry	Dry	CPS
SI-30	8/6/1999	2,974,199	268,927	5.79	154	35.3	CPS
SI-31	10/4/1999	2,974,524	271,929	Dry	Dry	Dry	CPS
SI-32	10/4/1999	2,974,678	272,015	Dry	Dry	Dry	CPS
SI-33	10/8/1999	2,975,750	272,657	7.29	163	23.0	CPS
SI-34	10/8/1999	2,977,491	272,847	7.83	149	23.4	CPS
SI-35	10/4/1999	2,978,477	273,046	6.86	188	26.2	CPS
SI-36	10/4/1999	2,979,471	273,146	Dry	Dry	Dry	CPS
SI-37	10/4/1999	2,979,414	274,727	9.26	146	29.2	CPS
SI-38	10/5/1999	2,980,152	275,882	Dry	Dry	Dry	Alcoa

Table C-14 (Continued)

Surface Impoundment Identification Number	Date Inventoried	Approximate Location (TX-C State Plane) (feet)		Field Water Quality Information			
		Easting	Northing	pH (standard units)	Conductivity (umhos/cm)	Temperature (°C)	Land Owner
SI-39	10/4/1999	2,979,722	277,490	9.60	142	29.7	CPS
SI-40	10/6/1999	2,983,928	280,578	8.11	137	25.2	Private
SI-41	10/6/1999	2,985,648	282,245	8.48	157	24.8	CPS
SI-42	10/6/1999	2,987,945	285,366	8.67	194	25.0	CPS
SI-43	10/5/1999	2,989,975	287,210	8.56	81	26.9	CPS
SI-44	10/5/1999	2,991,332	288,660	8.37	85	26.9	Alcoa
SI-45	10/8/1999	2,992,057	289,460	8.87	104	27.6	Alcoa
SI-46	10/8/1999	2,991,794	290,483	9.01	109	27.8	Private
SI-47	10/5/1999	2,992,424	291,014	Dry	Dry	Dry	Private
SI-48	10/6/1999	2,994,200	292,626	Dry	Dry	Dry	Alcoa
SI-49	10/6/1999	2,994,552	294,053	8.14	79	24.6	Alcoa
SI-50	10/6/1999	2,996,560	296,577	8.21	186	23.8	Alcoa
SI-51	10/6/1999	2,997,563	297,626	7.22	100	22.2	Alcoa
SI-52	10/6/1999	2,998,093	298,405	7.25	82	22.7	Alcoa
SI-53	10/5/1999	2,991,457	289,628	Dry	Dry	Dry	Alcoa
SI-54	1/19/2000	2,967,823	260,547	5.57	133	20.6	CPS
SI-55	1/19/2000	2,968,461	262,619	Dry	Dry	Dry	CPS
SI-56	1/19/2000	2,968,528	262,069	6.46	142	23.3	CPS
SI-57	1/19/2000	2,968,452	262,029	5.91	780	24.0	CPS
SI-58	1/19/2000	2,966,392	259,543	6.92	101	26.6	CPS
SI-59	1/20/2000	2,968,421	262,915	7.54	98	13.9	CPS
SI-60	1/20/2000	2,968,574	263,074	7.00	77	13.3	CPS
SI-61	1/20/2000	2,968,596	263,250	6.40	158	12.4	CPS
SI-62	1/20/2000	2,968,487	263,289	7.02	114	11.5	CPS
SI-63	1/20/2000	2,969,327	263,273	7.27	75	14.3	CPS
SI-64	1/20/2000	2,969,919	265,030	7.17	87	14.4	CPS
SI-65	1/20/2000	2,962,474	256,006	8.22	123	14.8	CPS
SI-66	1/20/2000	2,963,813	255,749	6.96	272	15.9	CPS
SI-67	1/20/2000	2,964,488	256,081	7.72	264	15.9	CPS
SI-68	1/20/2000	2,964,022	257,043	8.00	73	16.5	CPS
SI-69	1/20/2000	2,964,316	257,146	5.77	136	15.7	CPS
SI-70	1/21/2000	2,963,949	252,935	Dry	Dry	Dry	Private
SI-71	1/21/2000	2,965,013	252,772	10.60	90	16.9	CPS
SI-72	1/21/2000	2,965,020	253,617	10.10	78	16.4	CPS
SI-73	1/21/2000	2,964,620	254,089	7.63	70	17.7	CPS
SI-74	1/21/2000	2,964,085	253,768	8.70	960	15.3	CPS
SI-75	1/21/2000	2,964,297	254,218	11.66	235	13.0	CPS
SI-76	1/21/2000	2,964,322	254,502	10.75	431	16.7	CPS

Table C-14 (Continued)

Surface Impoundment Identification Number	Date Inventoried	Approximate Location (TX-C State Plane) (feet)		Field Water Quality Information			
		Easting	Northing	pH (standard units)	Conductivity (umhos/cm)	Temperature (°C)	Land Owner
SI-77	1/21/2000	2,964,159	254,793	11.13	376	15.8	CPS
SI-78	1/21/2000	2,963,155	255,504	7.71	86	15.1	CPS
SI-79	1/21/2000	2,962,935	255,195	9.76	95	15.2	CPS
SI-80	1/21/2000	2,962,644	255,209	8.58	121	15.9	CPS
SI-81	1/21/2000	2,961,584	255,441	7.74	128	16.8	CPS
SI-82	1/21/2000	2,962,819	254,306	Dry	Dry	Dry	CPS
SI-83	1/21/2000	2,961,329	254,321	10.37	108	15.3	CPS
SI-84	1/22/2000	2,966,054	256,289	Dry	Dry	Dry	CPS
SI-85	1/22/2000	2,965,193	257,282	Dry	Dry	Dry	CPS
SI-86	1/22/2000	2,965,517	256,110	9.68	206	13.7	CPS
SI-87	1/22/2000	2,965,644	254,796	8.27	173	13.6	CPS
SI-88	1/22/2000	2,964,749	254,987	10.93	233	12.8	CPS
SI-89	1/22/2000	2,966,478	256,773	Dry	Dry	Dry	CPS
SI-90	1/22/2000	2,965,288	258,275	Dry	Dry	Dry	CPS
SI-91	1/22/2000	2,968,633	264,134	Dry	Dry	Dry	CPS
SI-92	1/22/2000	2,968,663	264,084	7.52	138	17.6	CPS
SI-93	1/22/2000	2,968,698	264,015	Dry	Dry	Dry	CPS
SI-94	1/22/2000	2,977,355	268,829	Dry	Dry	Dry	CPS
SI-95	1/22/2000	2,977,635	269,077	6.87	68	18.4	CPS
SI-96	1/22/2000	2,977,186	268,923	Dry	Dry	Dry	CPS
SI-97	4/27/2000	2,975,297	264,417	6.91	102.4	21.9	CPS
SI-98	1/22/2000	2,974,012	273,522	8.60	157	18.4	Private
SI-99	4/18/2000	2,967,978	252,714	8.48	1,360	23.9	Private
SI-100	4/17/2000	2,979,616	271,669	7.06	108	33.4	Private
SI-101	4/27/2000	2,978,185	268,667	Dry	Dry	Dry	CPS
SI-102	4/17/2000	2,979,053	268,415	7.69	66	31.9	CPS
SI-103	4/26/2000	2,973,895	252,178	6.68	54.4	26.2	Private
SI-104	5/5/2000	2,964,422	250,714	3.55	1,587	26.0	CPS
SI-105	5/5/2000	2,964,853	250,875	8.02	93.4	25.7	CPS
SI-106	5/5/2000	2,965,295	250,541	8.04	119.1	26.4	CPS
SI-107	5/5/2000	2,965,623	248,120	6.84	50.9	50.9	CPS
SI-108	4/20/2000	2,967,609	245,933	7.23	107	21.2	CPS
SI-109	4/20/2000	2,967,756	245,992	6.45	154	21.5	CPS
SI-110	4/20/2000	2,967,848	246,205	7.46	145	21.6	CPS
SI-111	4/20/2000	2,968,247	246,515	7.02	114	21.8	CPS
SI-112	4/19/2000	2,967,381	248,033	9.58	99	27.0	Private
SI-113	4/18/2000	2,967,172	249,188	8.40	82	27.5	Private
SI-114	4/18/2000	2,967,432	250,076	8.45	79	27.5	Private

Table C-14 (Continued)

Surface Impoundment Identification Number	Date Inventoried	Approximate Location (TX-C State Plane) (feet)		Field Water Quality Information			
		Easting	Northing	pH (standard units)	Conductivity (umhos/cm)	Temperature (°C)	Land Owner
SI-115	4/20/2000	2,966,885	250,563	7.83	72	24.4	Private
SI-116	4/18/2000	2,967,655	250,111	9.94	57	27.5	Private
SI-117	4/18/2000	2,967,762	249,896	8.50	76	28.0	Private
SI-118	4/19/2000	2,968,178	248,994	8.30	83	29.1	Private
SI-119	4/19/2000	2,969,509	248,925	9.13	122	28.0	CPS
SI-120	4/19/2000	2,969,157	249,672	9.14	98	28.2	Private
SI-121	4/19/2000	2,969,665	250,021	9.62	92	29.4	Private
SI-122	4/18/2000	2,968,006	251,238	9.35	204	25.1	Private
SI-123	5/3/2000	2,966,515	251,379	6.78	101	22.3	CPS
SI-124	4/18/2000	2,967,927	251,698	9.01	1,390	26.1	Private
SI-125	4/20/2000	2,971,367	251,149	8.25	133	28.0	CPS
SI-126	4/20/2000	2,970,366	252,056	8.74	89	27.1	CPS
SI-127	4/20/2000	2,970,436	252,149	7.76	79	27.9	CPS
SI-128	4/18/2000	2,969,453	252,428	7.85	101	25.1	Private
SI-129	4/18/2000	2,967,978	252,714	8.63	1,400	24.1	Private
SI-130	4/18/2000	2,967,316	253,922	7.54	102	23.8	Private
SI-131	4/21/2000	2,970,494	253,362	7.83	175	22.1	CPS
SI-132	4/21/2000	2,971,154	253,020	7.53	70	25.0	CPS
SI-133	4/26/2000	2,972,840	252,328	7.29	72.2	26.0	Private
SI-134	4/26/2000	2,973,072	252,149	7.76	135.4	26.8	Private
SI-135	4/26/2000	2,973,040	252,825	7.31	97.8	22.2	Private
SI-136	4/26/2000	2,973,334	254,063	7.31	123.3	26.1	Alcoa
SI-137	4/21/2000	2,971,275	254,566	10.24	196	27.3	Alcoa
SI-138	4/21/2000	2,970,615	254,246	8.09	210	24.2	CPS
SI-139	4/21/2000	2,968,312	255,237	7.29	94	21.2	CPS
SI-140	4/21/2000	2,968,261	256,291	8.33	177	21.1	CPS
SI-141	4/24/2000	2,972,176	255,664	9.79	87.1	28.7	Alcoa
SI-142	4/26/2000	2,974,757	255,241	8.32	63.6	31.1	Alcoa
SI-143	4/26/2000	2,973,401	255,982	Dry	Dry	Dry	CPS
SI-144	4/24/2000	2,973,447	256,256	7.03	120.3	28.2	CPS
SI-145	4/24/2000	2,973,900	256,749	7.78	68.3	25.3	CPS
SI-146	4/24/2000	2,972,857	257,059	7.86	52.8	26.1	CPS
SI-147	4/24/2000	2,967,772	258,464	7.00	99.1	22.0	CPS
SI-148	4/24/2000	2,968,364	259,197	7.36	135.9	22.7	CPS
SI-149	4/24/2000	2,971,454	259,396	Dry	Dry	Dry	CPS
SI-150	4/24/2000	2,971,455	259,577	7.72	73.2	31.6	CPS
SI-151	4/26/2000	2,974,939	257,880	5.61	46.7	19.2	CPS
SI-152	4/26/2000	2,974,602	258,635	7.14	110.5	21.8	CPS

Table C-14 (Continued)

Surface Impoundment Identification Number	Date Inventoried	Approximate Location (TX-C State Plane) (feet)		Field Water Quality Information			
		Easting	Northing	pH (standard units)	Conductivity (umhos/cm)	Temperature (°C)	Land Owner
SI-153	5/4/2000	2,976,314	260,393	6.71	64.4	29.0	CPS
SI-154	5/4/2000	2,977,352	260,982	7.29	103.3	27.2	Private
SI-155	5/4/2000	2,976,638	261,573	9.10	60.6	28.3	CPS
SI-156	5/4/2000	2,975,282	261,761	8.21	48.9	30.9	CPS
SI-157	4/25/2000	2,974,265	262,046	Dry	Dry	Dry	Private
SI-159	4/25/2000	2,972,537	261,747	7.82	93	30.8	CPS
SI-160	4/25/2000	2,971,953	261,658	8.92	85.9	23.5	CPS
SI-161	4/25/2000	2,969,665	261,776	7.07	161.1	20.6	CPS
SI-162	4/25/2000	2,969,961	261,934	6.66	112.5	19.9	CPS
SI-163	4/25/2000	2,972,710	262,137	7.97	80	29.5	CPS
SI-164	4/25/2000	2,974,065	262,046	Dry	Dry	Dry	CPS
SI-165	5/4/2000	2,976,410	262,040	7.70	72.4	26.3	CPS
SI-166	5/4/2000	2,978,035	262,405	7.56	85.3	24.6	CPS
SI-167	5/4/2000	2,978,007	262,619	6.29	124	21.6	CPS
SI-168	5/4/2000	2,975,203	262,687	6.80	71.3	28.7	CPS
SI-169	4/25/2000	2,971,602	263,409	7.13	85	28.0	CPS
SI-170	4/27/2000	2,974,431	263,782	6.77	103.4	23.5	CPS
SI-171	4/27/2000	2,975,795	263,736	7.00	95.3	20.6	CPS
SI-172	4/27/2000	2,978,646	264,602	7.14	74.6	30.7	CPS
SI-173	5/3/2000	2,974,147	265,241	7.04	143.7	27.5	CPS
SI-174	5/3/2000	2,974,512	265,396	6.13	77.7	23.8	CPS
SI-175	5/3/2000	2,972,920	266,505	7.22	106.1	30.5	CPS
SI-176	5/3/2000	2,976,019	267,818	6.94	37.9	29.5	CPS
SI-177	4/27/2000	2,980,660	265,902	Dry	Dry	Dry	Private

Source: Alcoa 2000 (Volume 5).

Table C-15
Permitted Surface Water Users in the Vicinity of the Sandow Mine

Name	Water Right Number	Location			Permit	Use	Amount (acre-feet/year)	Reservoir Capacity (acre-feet)	Date Issued	Facility
		County	Latitude	Longitude						
Brazos River Authority	005164	Washington	30.32	-96.52	5164	Municipal/ domestic	48,000	160,110	12/14/87	Somerville Lake
Alcoa	005272	Milam	30.57	-97.04	1608B	Industrial	14,000	15,650	1/14/88	Alcoa Lake
Alcoa	005540	Milam	30.58	-97.08	5540	Domestic/ livestock	--	356	12/20/96	North Area End Lake
Alcoa	005540	Milam	30.58	-97.08	5540	Domestic/ livestock	--	7,173	12/20/96	East Area End Lake
Rockdale Country Club	005273	Milam	30.59	-97.04	3546	Irrigation	1	2	1/14/88	--
Private	005274	Lee	30.50	-96.99	5274	Irrigation	18		1/14/88	--
Birch Creek Forest Properties	005279	Burleson	30.31	-96.61	5279	Recreation	--	15	1/14/88	--

Source: Alcoa 2001b (Volume 2).

Table C-16
Permitted Surface Water Users in the Vicinity of and Downstream of the Three Oaks Mine

Name	Water Right Number	Location			Description	Permit	Use	Amount (acre-feet per year)	Date Issued
		County	Latitude	Longitude					
City of Brenham	000281	Washington	30.3222	-96.5249	Somerville Lake	Contractural permit/ agreement	Municipal/ Domestic	1,680	4/24/75
City of Brenham	002041	Washington	30.3222	-96.5249	Somerville Lake	Contractural permit/ agreement	Municipal/ Domestic	135	10/1/94
Private	003775	Fayette	29.9842	-97.0356	Colorado River	Application/ permit	Irrigation	35	11/10/77
Frisch Auf Valley Country Club	003939	Fayette	29.8964	-96.8871	Buckners Creek/ Colorado River	Application/ permit	Irrigation	36	2/14/79
Sun West Investments, Inc.	005084	Bastrop	30.0709	-97.301	Unamed tributary Colorado River	Application/ permit	Irrigation	4	10/31/86
Brazos River Authority	005164	Washington	30.3222	-96.5249	Somerville Lake	Certificate of Adjudication	Municipal/ Domestic	48,000	12/14/87
Private	005402	Bastrop	30.1215	-97.3537	Colorado River	Certificate of Adjudication	Irrigation	348	8/26/88
Private	005403	Bastrop	30.1149	-97.3320	Colorado River	Certificate of Adjudication	Irrigation	5	8/26/88
Private	005407	Bastrop	30.0188	-97.2212	Line Creek/ Colorado River	Certificate of Adjudication	Irrigation	80	8/26/88
Private	005418	Fayette	29.9769	-96.9313	Blair Branch/ Colorado River	Certificate of Adjudication	Irrigation	128	8/26/88
Private	005425	Fayette	29.8928	-96.8219	Colorado River	Certificate of Adjudication	Irrigation	76	8/26/88
Private	005426	Fayette	29.8910	-96.8190	Colorado River	Certificate of Adjudication	Irrigation	10	8/26/88
Private	005427	Fayette	29.8909	-96.8190	Colorado River	Certificate of Adjudication	Irrigation	14	8/26/88
Private	005428	Fayette	29.8909	-96.8191	Colorado River	Certificate of Adjudication	Irrigation	15	8/26/88

Source: Alcoa 2001b (Volume 2).

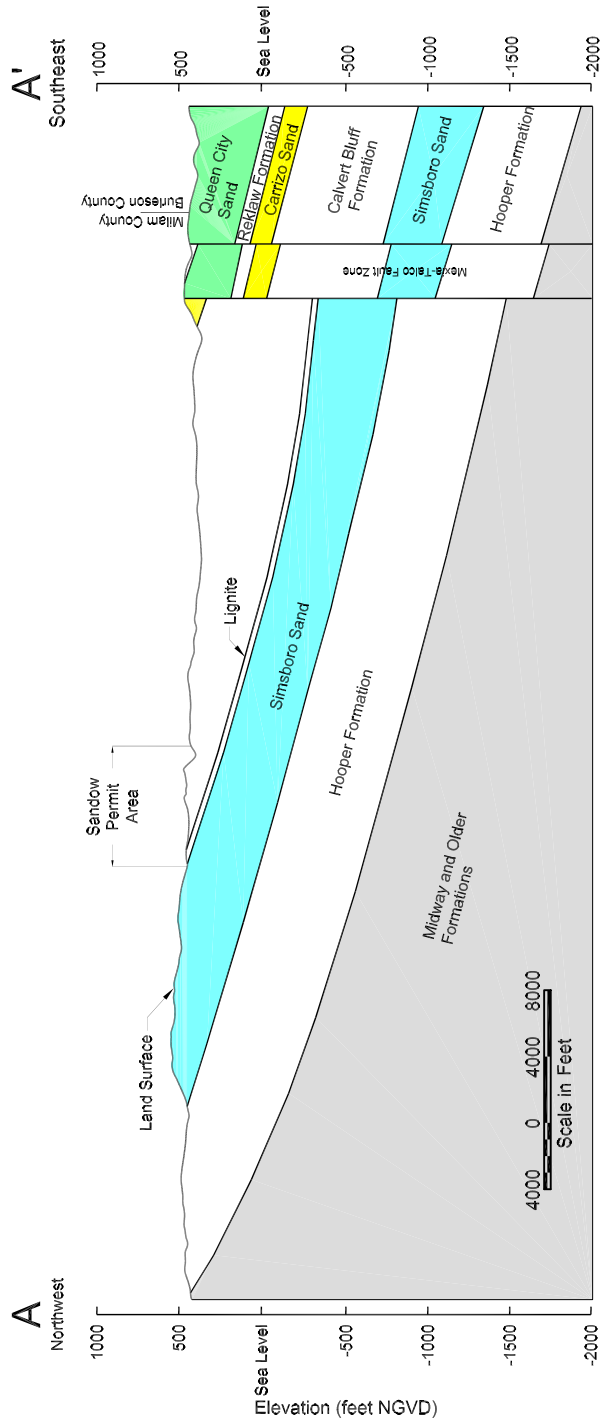
Table C-17
Wastewater Discharge Permits Near the Three Oaks Mine

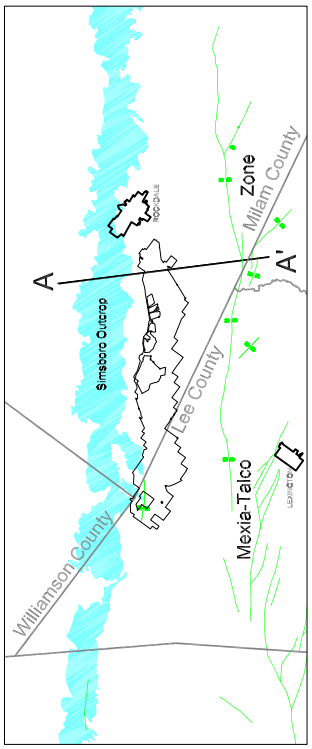
Permit Number	Permitee	Facility	Classified Segment[1]	County
WQ0000395-000	Aluminum Company of America	Rockdale Plant	1212	Milam
WQ0000444-000	Acme Brick Company	Plant II Clay Mine/Acme	1434	Bastrop
WQ0001414-000	Elgin Butler Brick Company	Clay Mine/Elgin Butler Brick	1428	Bastrop
WQ0002052-000	Lower Colorado River Authority	Sim Gideon SES	1434	Bastrop
WQ0002632-000	Lower Colorado River Authority	Bastrop County Plant	1428	Bastrop
WQ0003720-000	Tiffany Brick Company	Tiffany Brick	1428	Bastrop
WQ0010016-001	City of Lexington	City of Lexington	1212	Lee
WQ0010100-001	Lower Colorado River Authority	LCRA-City of Elgin	1434	Bastrop
WQ0010658-001	City of Rockdale	City of Rockdale	1212	Milam
WQ0012007-001	Lee County FWSD No. 1	Lee County FWSD 001	1212	Lee
WQ0014103-001	Lower Colorado River Authority	LCRA	1434	Bastrop
WQ0013548-001	Lower Colorado River Authority	Camp Swift	1428	Bastrop
WQ0011500-001	Texas Parks and Wildlife	Summerville – Noils Creek	1212	Lee
WQ0014110-001	Southwest Milam WSC	Southwest Milam WSC	1212	Milam

[1]1212 = Somerville Lake.
1428 = Colorado River below Town Lake.
1434 = Colorado River above LaGrange.

Source: Alcoa 2001b (Volume 2).

FIGURES





Source: Adapted from figure from RWHA 1999.

Three Oaks Mine

Figure C-1

Hydrogeologic Section of Sandow Mine Area

EXPLANATION

- Quaternary to Recent alluvial and fluviatile deposits (shown only in areas near the outcrop trend of the Carrizo Formation and Wilcox Group)
- Tcc — Carrizo Formation
- Twlcb — Calvert Bluff Formation of the Wilcox Group
- Twlh — Hooper Formation of the Wilcox Group
- Twl — Wilcox Group undifferentiated
- 400 — Line showing approximate altitude of water levels in the Carrizo–Wilcox aquifer. (Interval is 50 feet)

LIMESTONE COUNTY
FALLS COUNTY
MILAM COUNTY
BURLESON COUNTY
ROBERTSON COUNTY
BRAZOS COUNTY
LEE COUNTY
WASHINGTON COUNTY
FAYETTE COUNTY
BASTROP COUNTY

Marlin
Rosebud
Cameron
Rockdale
Elgin
Giddings
Smithville
Ledbetter
La Grange
Franklin
Calvert
Hearne
Bryan
College Station
Caldwell
Brenham
Lake Somerville
Concord
Normangee

Twl
Twlh
Twlcb
Tcc

Brazos River
East Yegua Creek
West Yegua Creek
Yegua Creek
Navasota River
Colorado River

Source: Adapted from Thorkildson and Price 1991.

N

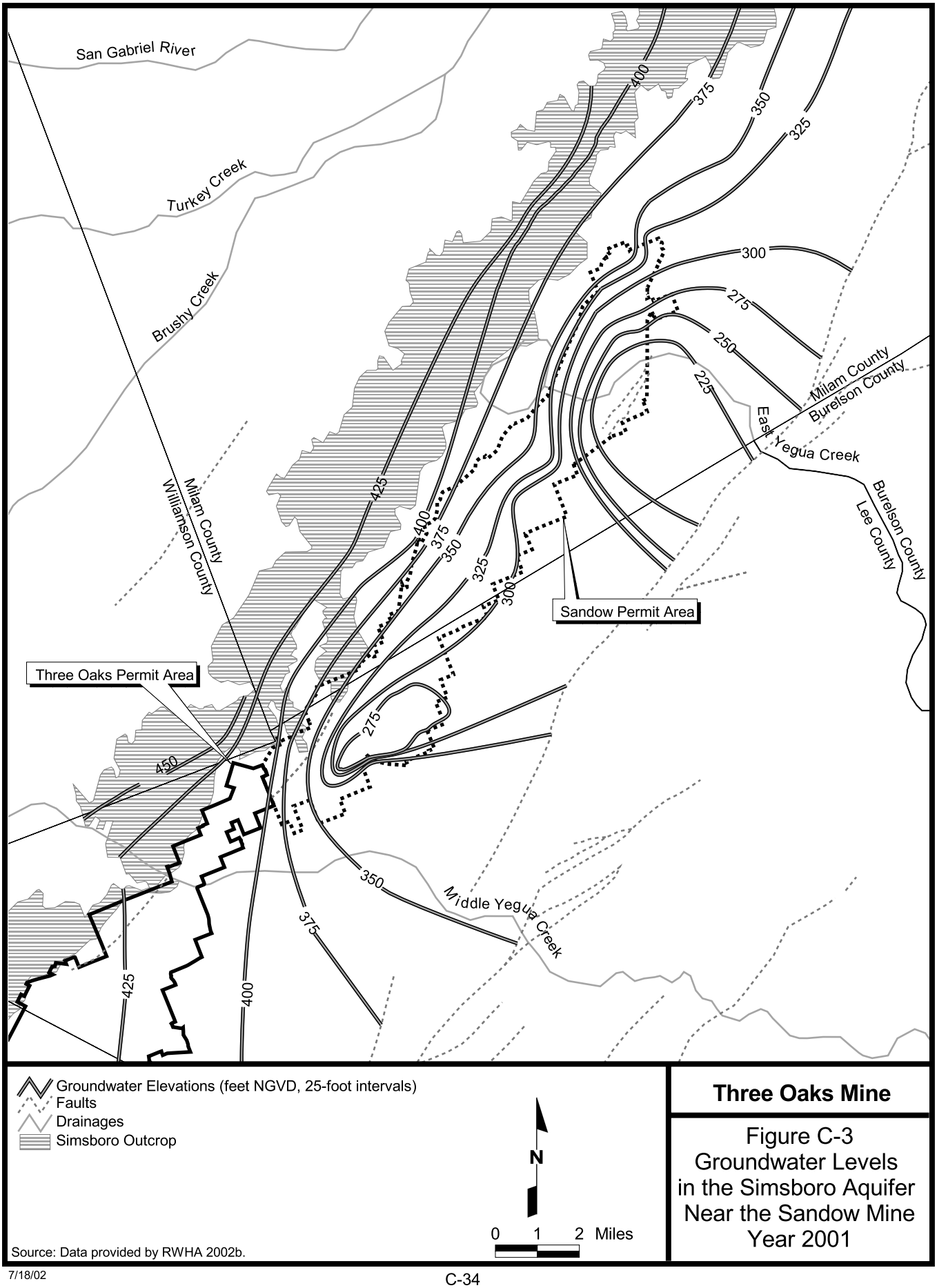
0 5 10 15 20 25 Miles
Scale

Three Oaks Mine

Figure C-2

General Groundwater Levels in the Carrizo-Wilcox Aquifer System

6/14/02



Three Oaks Mine

Figure C-3
Groundwater Levels
in the Simsboro Aquifer
Near the Sandow Mine
Year 2001

EXPLANATION

- Quaternary to Recent alluvial and fluviatile deposits (shown only in areas near the outcrop trend of the Carrizo Formation and Wilcox Group)
- Tcc — Carrizo Formation
- Twicb — Calvert Bluff Formation of the Wilcox Group
- Twis — Simsboro Formation of the Wilcox Group
- Twih — Hooper Formation of the Wilcox Group
- Twi — Wilcox Group undifferentiated
- ○ Carrizo Formation
- ● Calvert Bluff Formation
- □ Simsboro Formation
- ▲ Wilcox Group undifferentiated
- ■ Carrizo–Wilcox aquifer undifferentiated

○ 43 / 104 / 523 — Sulfate concentration / Chloride concentration / Total dissolved-solids concentration (Chemical concentrations are in milligrams per liter)

LIMESTONE COUNTY
FALLS COUNTY
MILAM COUNTY
ROBERTSON COUNTY
BRAZOS COUNTY
BURLESON COUNTY
LEE COUNTY
WASHINGTON COUNTY
BASTROP COUNTY
FAYETTE COUNTY

Twis Twicb Twih Twi Tcc

N

0 5 10 15 20 25 Miles
Scale

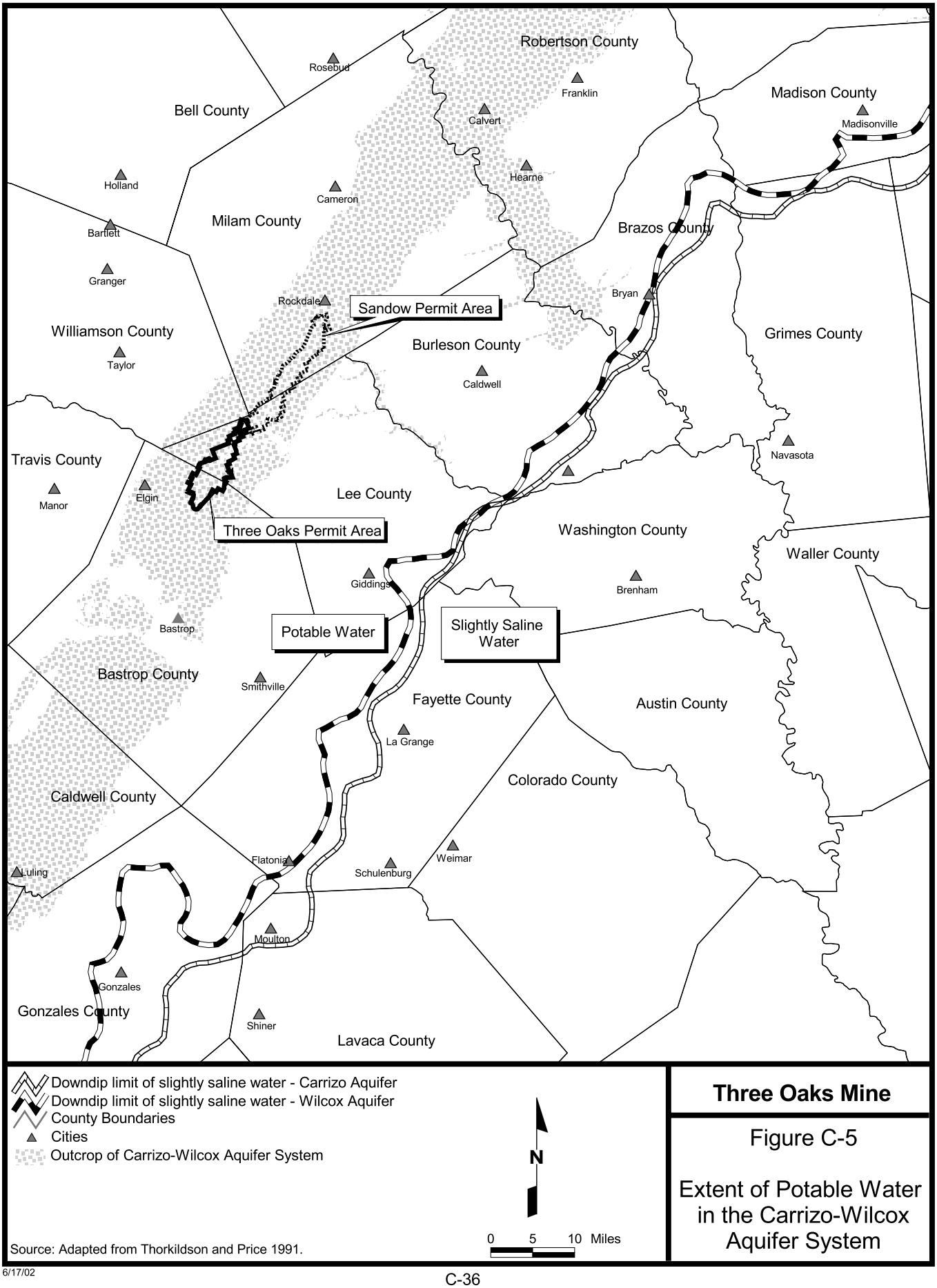
Source: Adapted from Thorkildson and Price1991.

Three Oaks Mine

Figure C-4

Groundwater Quality in the Carrizo-Wilcox Aquifer System

6/14/02

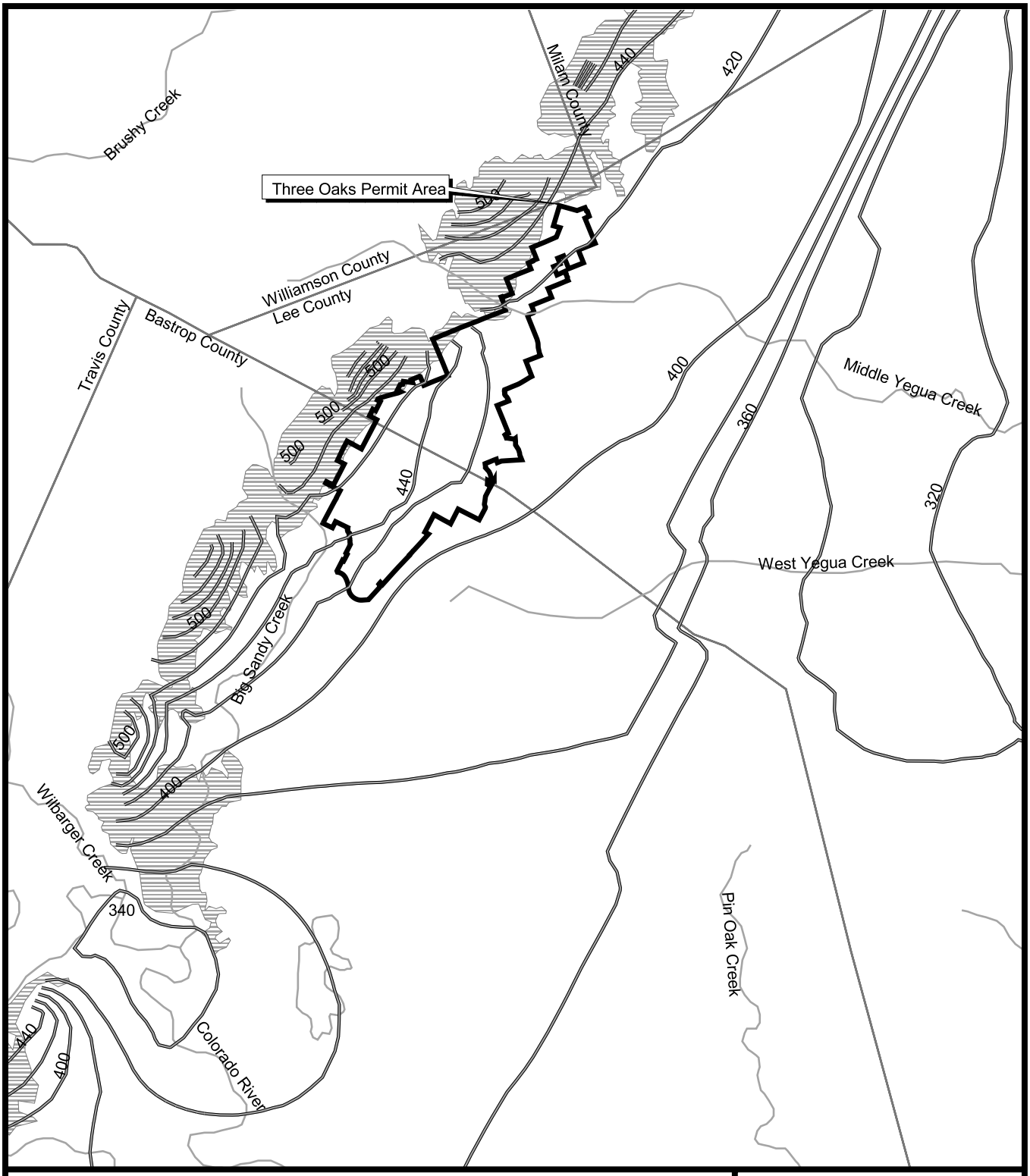


Three Oaks Mine

Figure C-5

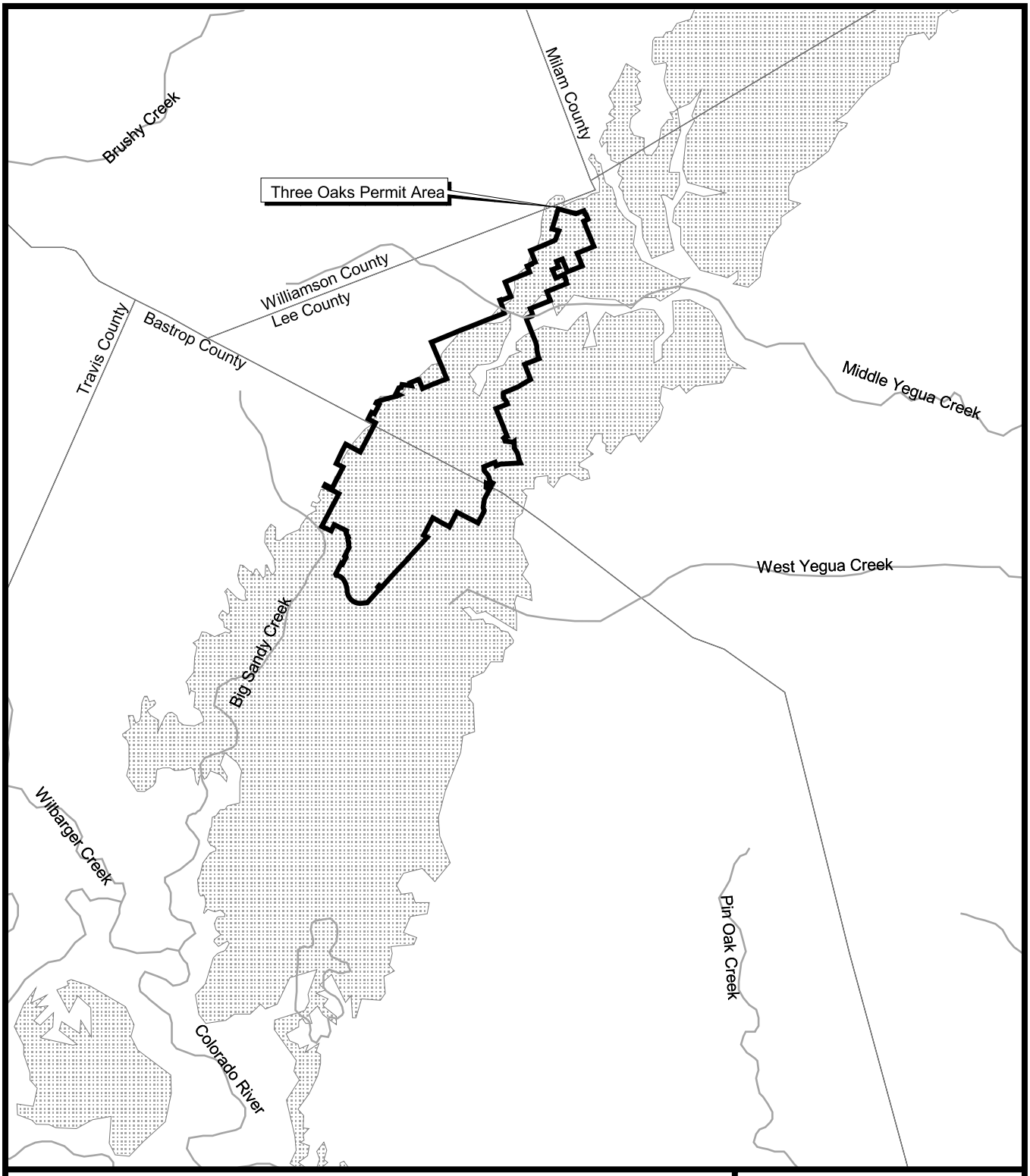
Extent of Potable Water in the Carrizo-Wilcox Aquifer System

6/17/02



Three Oaks Mine

Figure C-6
General Groundwater Levels in the Simsboro Aquifer Year 2000



Approximate Groundwater Elevation (feet NGVD, 20-foot intervals)
Drainages
Calvert Bluff Outcrop

Note: Contours are a generalized representation of groundwater levels in the upper Calvert Bluff sand units.

N

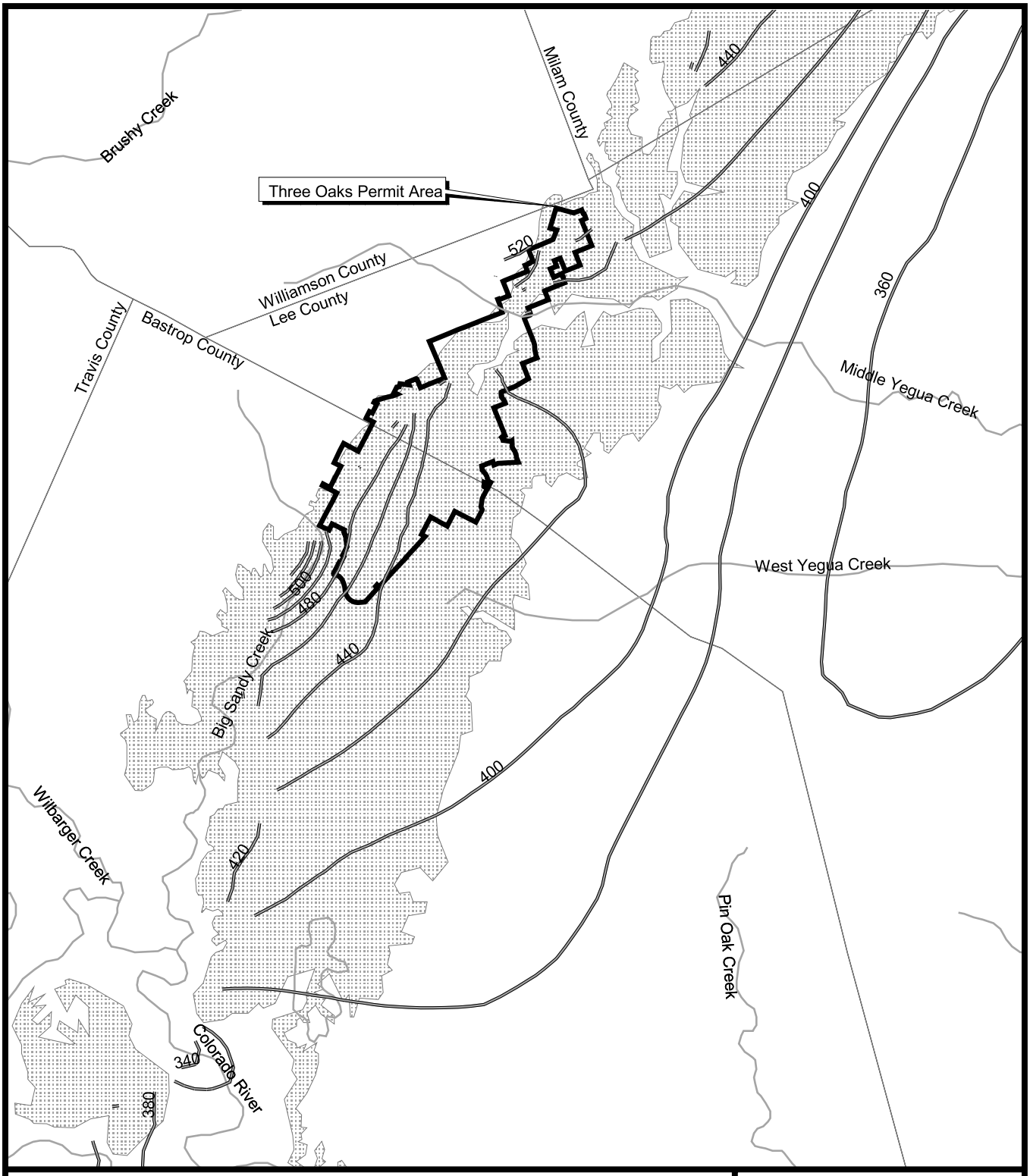
0 1 2 Miles

Source: Water elevation modeled by ENSR 2002.

Three Oaks Mine

Figure C-7
General Groundwater Levels in the Upper Calvert Bluff Aquifer

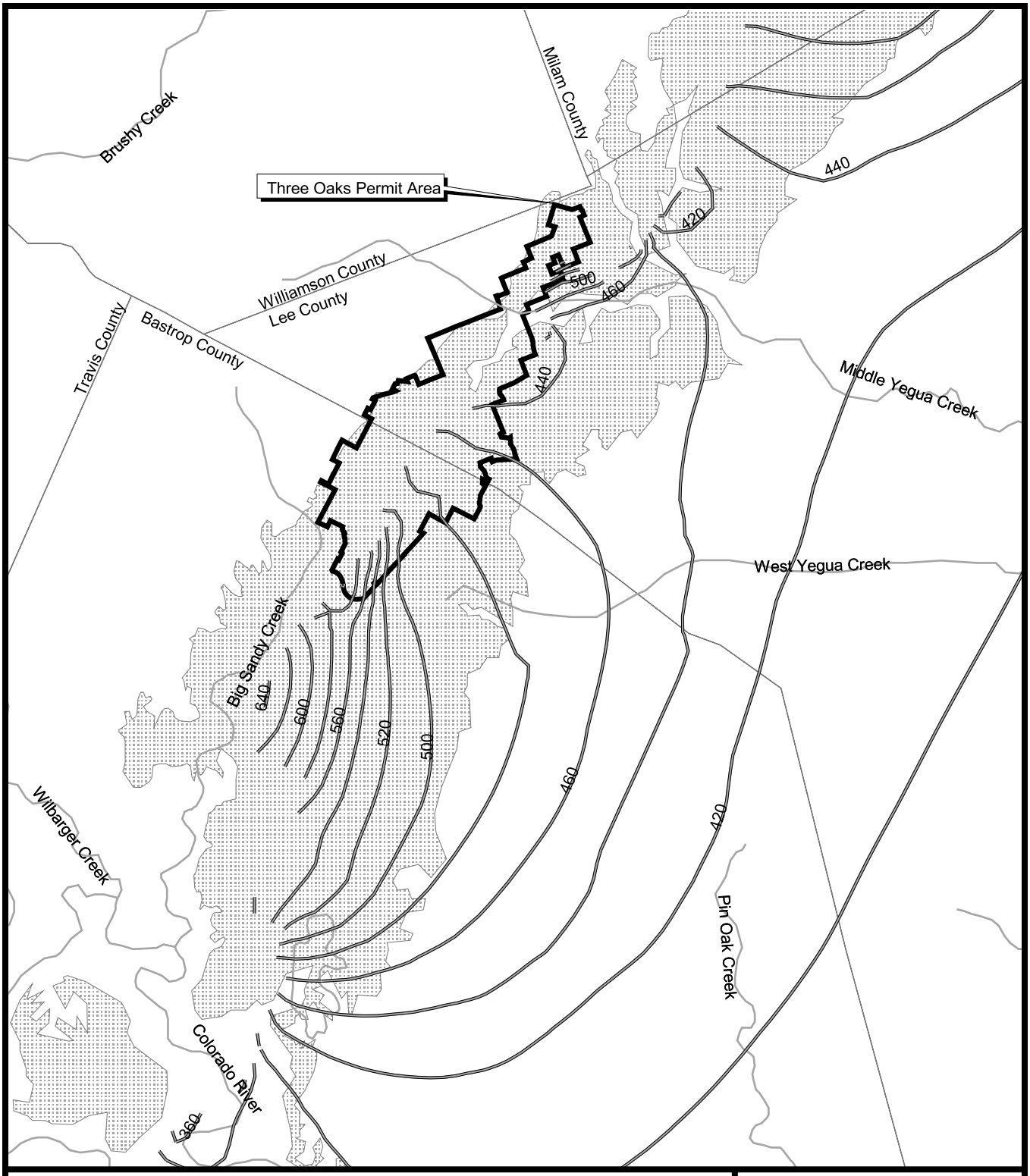
7/18/02



Three Oaks Mine

Figure C-8
General Groundwater Levels in the Calvert Bluff Aquifer 200 Lignite Zone

7/18/02



Approximate Groundwater Elevation (feet NGVD, 20-foot intervals)

Drainages

Calvert Bluff Outcrop

Note: Contours are a generalized representation of groundwater levels in the upper Calvert Bluff 800 lignite zone.

N

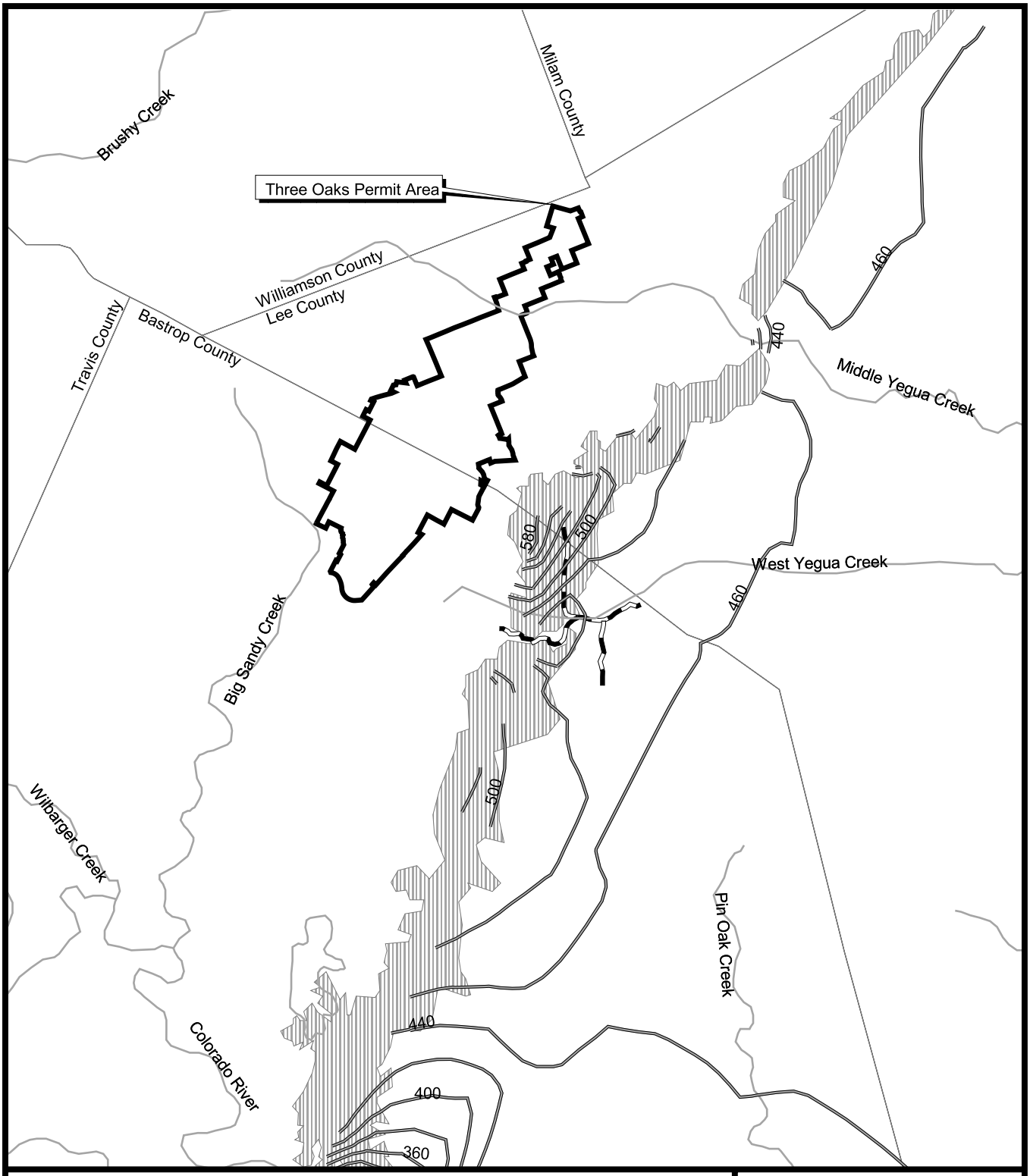
0 1 2 Miles

Source: Water elevation modeled by ENSR 2002.

Three Oaks Mine

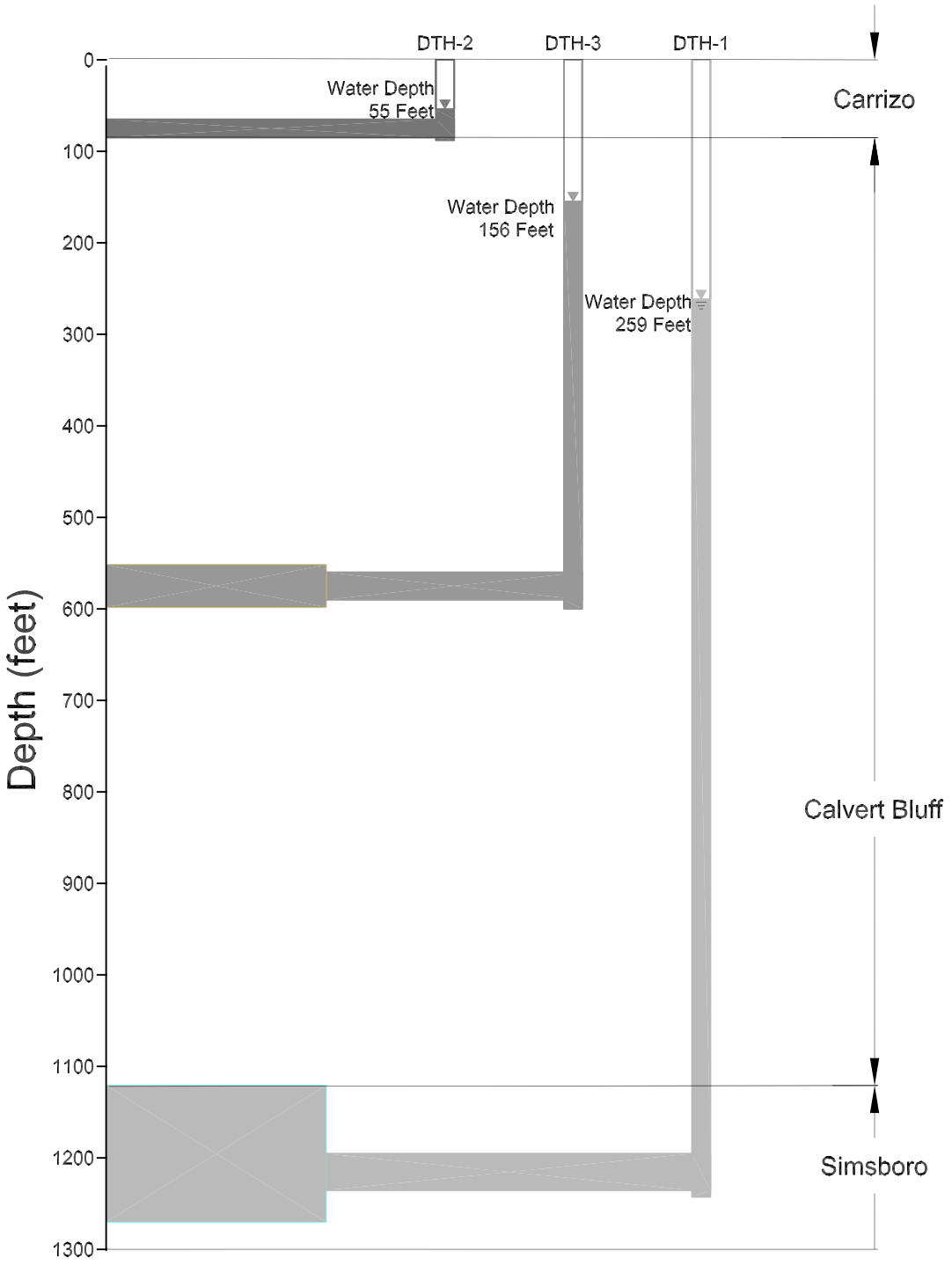
Figure C-9
General Groundwater Levels in the Calvert Bluff Aquifer 800 Lignite Zone

7/18/02



Three Oaks Mine

Figure C-10
General Groundwater Elevations in the Carrizo Aquifer
Year 2000



Note: Represents depth to groundwater below ground level.

Three Oaks Mine

Figure C-11
Vertical Depth to Groundwater Relationship Among Local Aquifers

Source: Adpated from figure from RWHA 2001.

7/18/02